National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Protocol for Monitoring Riparian Habitat and Associated Wetlands in the Pinnacles National Monument

Version 1.0

Natural Resource Report NPS/SFAN/NRR—2011/455

ON THE COVER
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September 2011

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Please cite this publication as:

Denn, M., and A. B. Ryan. 2011. Protocol for monitoring riparian habitat and associated wetlands in the Pinnacles National Monument: Version 1.0. Natural Resource Report NPS/SFAN/NRR—2010/455. National Park Service, Fort Collins, Colorado.

NPS 114/110565, September 2011

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Executive Summary

Current wetland conservation literature typically begins with dramatic descriptions of historic wetland losses that have occurred due to human activities throughout the world. It is therefore not surprising that numerous wetland-dependent species are threatened with extinction. Approximately 55% of the animals and 25% of the plants designated as threatened or endangered by the State of California depend on wetland habitats for their survival (Ferren *et al.* 1995). Besides species loss, another less documented but still important threat to wetlands is the widespread conversion of one wetland type to another. Wetland type-conversion can be caused by non-native plant species invasion or by local and regional anthropogenic perturbations. For example, palustrine herbaceous emergent wetland (*e.g.,* a meadow wetland) can convert to palustrine scrub shrub wetland due to changes in hydrologic regimes (Dahl 2006). In addition, local and regional stressors, such as impermeable surfaces in the watershed, channel modifications, and local hydrologic alterations, can degrade the structural complexity of remaining wetlands, which may result in the loss of biodiversity and resilience (Collins *et al.* 2008). Changes in extent, type, and condition of wetlands can greatly reduce the ecological services they provide. These services includes native wildlife and plant habitat, flood attenuation, nutrient cycling, and carbon sequestration, among others (Mitsch and Gosselink 2000).

Due to extensive urban and suburban development, California has lost more than 90 to 95 percent of certain wetland types, such as coastal salt marshes and riparian wetlands. These trends hold for the San Francisco Bay region as well. Wetlands throughout the San Francisco Bay Area have been lost and degraded due to historic and current grazing, introduction of exotic species, construction of levees and dams, and urbanization of watersheds. Wetland loss and degradation may accelerate in the future in response to altered hydrologic regimes resulting from climate change.

Pinnacles National Monument (NM) supports two primary wetland types: wetlands associated with springs and seeps that are not in stream channels and wetlands found in stream channels. Wetlands associated with springs and seeps at Pinnacles NM are assumed to be relatively permanent and supported by water stored for decades in rock fissures and permeable geologic strata (Borchers and Lyttge 2006). The predominant type of wetland at Pinnacles NM (i.e. those found in stream channels) are fed by groundwater or surface water or a combination of both. They can be relatively permanent in location, particularly when downslope of a spring or seep that provides year-round, interannually-stable flows. Alternatively, in-stream wetlands can be relatively ephemeral if fed primarily by surface water and near-surface groundwater from recent rains. These wetland types often wash out due to moderate-large periodic flood flows and will then reform elsewhere in the channel bed (Johnson 2009).

Although the core lands of Pinnacles NM have been protected as a National Monument for over a century, the monument still harbors many non-native plant and animal species. In addition, the monument has recently expanded to include former ranching lands that support even more non-native plant species than the core lands. Currently, many non-native species are so abundant and well distributed throughout the monument that they are too widespread to be targeted for active management. Some species, however, are noxious habitat-altering organisms that are, or may be, targeted by managers for removal despite their extent. These include wild pig (*Sus scrofa*), green sunfish and bluegill (*Lepomis spp*.), bullfrog (*Rana catesbeiana*), yellow star-thistle (*Centauria solstitialis*), Himalayan blackberry (*Rubus discolor*), and horehound (*Marrubium vulgare*) (NPS 2009). Crayfish (various genera) are not currently found within the monument but have a potential to invade from nearby lands (Johnson 2009).

At this time, the greatest risks to the natural habitats (and associated biota) at Pinnacles NM appears to be reductions in abundance of wetlands and reductions in extent and structural complexity of riparian vegetation communities. Individual in-stream wetlands or reaches of riparian habitat may be locally degraded by natural disturbances such as flood, wind, and rockfall. However, biota will adapt in both the short and long term as long as the abundance and quality of habitat is not degraded across the entire monument or across entire watersheds.

However, potential reductions in habitat extent or complexity at a landscape scale would most likely be a result of introduction and spread of non-native invasive plants, changes in temperature and precipitation regimes, and/or tectonic activity. Other possible stressors include changes in land use and waters upstream of Pinnacles National Monument - upstream either via the evident surface stream system or via the poorly-understood rock aquifer system underlying the monument. Upstream changes in land use may degrade wetlands and riparian habitats in Pinnacles NM through water extraction, water contamination, deposition of air-borne pollution, and introduction and spread of invasive non-native plants and animals.

The purpose of this protocol is to establish a long-term monitoring program for riparian and wetland habitats in Pinnacles NM. Monitoring in the monument can provide an early warning of wetland and riparian habitat change due to the threats described above. This early warning will allow monument managers to respond administratively to protect resources and focus on additional studies, if necessary.

This protocol seeks to track wetland abundance, riparian vegetation community structure, and channel morphology characteristics. Specifically, the monitoring objectives are:

Objective 1. Determine trends in the abundance of wetlands associated with stream channels at Pinnacles National Monument.

Objective 2. Determine trends in riparian vegetation communities (foliar cover for several general guilds, foliar cover of specific tree and shrub species, guild richness) at Pinnacles NM.

Objective 3. Determine trends in stream channel width and substrate size at Pinnacles NM.

Together these metrics will provide monument managers with information about changes in habitats and surface- and near-surface water availability that are critical to monument biota. Monument managers will benefit from understanding trends in wetland and riparian habitat extent and complexity. This understanding will allow NPS employees to make better decisions regarding management of wetland-dependent species, identify any opportunities for local or off-site mitigation, and respond to as yet unknown threats to these important habitats.

The primary target for data collection is all 100-meter-long reaches within 47 kilometers of stream corridor that have an upgradient catchment basin 3 square kilometers or greater. One third of these reaches will be evaluated each year for quantitative metrics to track changes in riparian vegetation and channel morphology. Data will be collected for the entire target stream network once every third year.

Data collection within the stream network occurs at three spatial scales; 1) the complete set of 100-meter long reaches of channel, bounded by the bankfull banks of the channel and the active floodprone area; 2) reaches are further subdivided 25 meter long segments; 3) transects oriented perpendicular to the center of the channel,

For each 100-meter reach, observers will identify vegetation community type, cover of dominant plant species, Rosgen stream type, and presence/absence and size class of wetlands. Observers will also evaluate several stream characteristics according to methods described in the California Rapid Assessment Method for Wetlands (CRAM). One out of every three segmetns will include a transect for evaluating riparian vegetation cover and channel substrate.

Fieldwork will be completed by two-person teams consisting of one technician with botanical and wetland identification skills and one technician with a basic knowledge of hydrogeomorphology. San Francisco Bay Area Network Inventory and Monitoring Program staff is responsible for hiring or contracting personnel for each field season. Monument staff will assist with arranging for local accommodations and logistics, including informing field staff of local access restrictions and in-park communication procedures.

Acknowledgements

Development of this protocol has been a joint effort, benefiting from the contributions from many network ecologists and managers. Many thanks go to these co-authors, including: Dave Press, Data Manager San Francisco Bay Area Network; Paul Johnson, Wildlife Biologist Pinnacles National Monument; Brent Johnson, Vegetation Management Specialist Pinnacles NM; Denise Louie, Chief of Resources Management Pinnacles NM; Lorraine Parsons, Vegetation Management Specialist, Point Reyes National Seashore; and Marcus Koenen, Inventory and Monitoring Program Manager, San Francisco Bay Area Network. Thanks go also to the National Park Service leaders whose vision and perseverance brought the NPS Inventory and Monitoring program to fruition while insisting on the highest of standards, including Gary Davis, Abbie Miller, Mike Soukup, and Steve Fancy. Finally, this protocol owes much of its form to the principal authors' mentors for ecological monitoring: Dan Salzer and John Willoughby.

1 - Background and Objectives

This monitoring program seeks to track changes in abundance of wetlands within the stream system at Pinnacles National Monument, California. In addition, the protocol will track changes in riparian vegetation and channel morphology at the monument. Together these metrics will provide monument managers with information about changes in habitats and surface- and near-surface water availability critical to monument biota. Revisions to this protocol are documented in SOP 1.

1.1 Monitoring Objectives

Monitoring objectives for this protocol have two primary targets: tracking abundance of in-stream wetlands (Objective 1), and tracking characteristics of riparian habitat (Objectives 2 and 3).

1. Determine trends in the abundance of wetlands associated with stream channels at Pinnacles National Monument.
2. Determine trends in vegetation communities (foliar cover for several general guilds, foliar cover of specific tree and shrub species, guild richness) of riparian areas at Pinnacles NM.
3. Determine trends in stream channel width and substrate size at Pinnacles NM.

1.2 Wetlands and Riparian Areas

1.2.1 Background

Change in wetland extent – overwhelming wetland loss – during the 19th and 20th centuries in the Western United States is of great concern to ecologists, managers, conservationists, and others. Most recent articles, papers, and text books addressing wetland conservation begin with dramatic descriptions of wetland loss due to human activities (*e.g.*, Dahl 1990). This has resulted in the threatened extinction of numerous wetland-dependent species, as 55% of the animals and 25% of the plants designated as threatened or endangered by the State of California depend on wetland habitats for their survival (Ferren *et al.* 1995).

Also of ecological concern, but less well documented, is widespread conversion of one wetland type to another due to local or regional anthropogenic perturbations, for example, palustrine herbaceous emergent wetland (*e.g.*, a meadow wetland) converting to palustrine scrub shrub wetland due to changing hydrologic regimes or invasions by non-native plant species (Dahl 2006). In addition, ecologists are concerned about degradation in the condition or structural complexity of remaining wetlands – which may include and result in loss of biodiversity and resilience – due to local and regional stressors such as impermeable surfaces in the watershed, channel modifications, and local hydrologic alterations (Collins *et al.* 2008).

Changes in extent, type, and condition of wetland can greatly reduce the ecological services wetlands provide. These services include – but are certainly not limited to – native wildlife and plant habitat, flood attenuation, nutrient cycling, and carbon sequestration (Mitsch and Gosslink 2000).

Wetlands are not as prevalent in arid and semi-arid climates such as found in California as they are in many other parts of the United States, which makes these wetlands particularly valuable for the functions they provide for humans and wildlife. Due to extensive urban and suburban development, California has lost more than 90 to 95 percent of some types of wetlands such as coastal salt marshes and riparian wetlands. These trends hold for the San Francisco Bay region as well. Wetlands throughout the San Francisco Bay Area have been lost and degraded due to historic and current grazing, introduction of exotic species, construction of levees and dams, and urbanization of watersheds. Wetland loss and degradation may accelerate in the future in response to altered hydrologic regimes resulting from climate change.

1.2.2 Wetlands and Riparian Habitat: Definitions and Classifications

This protocol seeks to track changes in two distinct but related landscape features at Pinnacles National Monument: wetlands found within the stream channel and riparian habitat.

1.2.2.1 Wetlands:

Wetlands are landscape features:

…where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. (Cowardin *et al.* 1979)

Wetlands include estuaries, mud flats, vegetated lakeshores, stream channels, vegetated seeps, marshes, and wet meadows. In California's arid environment wetlands are rare, often seasonal, and generally restricted to valley bottoms, river/ocean interfaces, lakeshores, and groundwater-fed springs.

1.2.2.2 Field-identification of Wetlands: When identifying wetlands in the field for the purposes of complying with wetland protection laws, observers distinguish wetlands from uplands by noting the presence of three specific wetland habitat characteristics: 1) a preponderance of plants that tolerate seasonally or permanently saturated substrates; 2) soil characteristics that develop due to inundation or saturation; and 3) indications of wetland hydrology.

Field identification of wetlands is generally accompanied by mapping of wetland boundaries. The standard US protocol for delineating the boundaries of wetlands in the field is the Army Corps of Engineers' Wetland Delineation Manual (Environmental Laboratory 1987) and its regional supplements (collectively referred to herein as the '87 Manual). The '87 Manual prescribes mapping areas as wetlands that exhibit all three wetland characteristics. The National Park Service generally follows techniques in the '87 Manual for identifying hydrophytic vegetation, hydric soils, and indications of wetland hydrology; however, the NPS maps wetland areas that have wetland hydrology but may be missing hydrophytic vegetation or hydric soils (NPS 2008).

In order to evaluate whether a site has a preponderance of wetland plants, plant species in the potential wetland area are identified and compared against a list of hydrophytic plants (Reed 1988, Reed 1996). Wetland soils are identified by color and structural characteristics, and compared against a set of criteria for hydric soils found in the Army Corps of Engineers Arid West Supplement (USACOE 2008). Wetland hydrology is defined by the US Army Corps of Engineers as: "fourteen or more consecutive days of flooding or ponding or a water table thirty centimeters or less below the soil surface during the growing season, at a minimum frequency of five years in ten" (USACOE 2008). However, identification of wetland hydrology most often occurs via a single site visit and is based on presence or absence of specific field indicators of wetland hydrology (Environmental Laboratory 1987). Local field staff who visit a particular site many times throughout the year can also advise on whether surface water persists at the site through the growing season.

Firm delineation of the "boundaries" of wetlands is convenient for managing, characterizing, and studying high-value wetland resources. Because wetland boundaries often exhibit gradual ecotonal transitions - grading from persistent saturation or flooding in lower topographic portions of the site, to intermittently saturated or flooded areas on the margins, then to uplands - the cutoff thresholds for boundary mapping must be somewhat arbitrary, not reflecting true ecological complexity. However, correct usage of wetland mapping protocols produces highly-repeatable wetland boundary maps (Environmental Laboratory 1987). Wetlands are also mapped remotely - with much degraded local-scale accuracy - via photointerpretation of landscape-scale satellite imagery. The most commonly referenced example of this are the US Fish and Wildlife Service National Wetlands Inventory maps (USFWS 2009).

1.2.2.3 Wetland Classification: Classification of wetlands - that is, grouping mapped wetlands with similar characteristics into pre-defined categories - can help ecologists and managers detect patterns on the landscape, anticipate wetland functions, and ascertain long-term changes in wetlands.

Wetland classification systems typically do not prescribe techniques to map wetland boundaries. Generally, observers map wetland boundaries via a delineation protocol - such as is found in the '87 Manual - then describe the mapped wetland according to a classification system. Therefore, application of one wetland classification system versus another will result in a map with the same delineated wetland boundaries but assign mapped wetlands to a different set of wetland categories.

Wetlands are typically classified according to sites' water sources and landscape positions. For example, the National Park Service has adopted the Fish and Wildlife Service Classification of Wetlands and Deepwater Habitats of the United States (Cowardin *et al.* 1979) for describing wetland types. This system identifies wetlands as Marine, Estuarine, Riverine, Lacustrine, or Palustrine dependent on water source from the ocean, ocean and river, river, lake, or groundwater. This classification further subdivides wetland types by landscape position, vegetation structure, and substrate (see SOP 7 for classification).

Other wetland classification systems group wetlands by similar criteria but use more detailed hydrology and geomorphologic categories - for example, as described in the Landscape/Landform/Water Flow Path/Water Body (LLWW) system (Tiner 2003) and the Hydrogeomorphic Method (HGM) (Brisson *et al.* 1995) - or fewer categories of water source, such as the California Rapid Assessment Method (CRAM) (Collins *et al.* 2008).

Some ecologists and managers also classify wetlands by composition of the dominant vegetation community. Observers characterize the vegetation community at a site based on a field reconnaissance protocol (*e.g.,* Collins *et al.* 2008, CNPS 2007), and then create categories based on observed plant associations. Alternately, observers may fit the observed vegetation into a pre-determined set of vegetation communities, such as is found in a local classification system (*e.g.,* Kittel *et al.* 2009, Holland 1986).

1.2.2.4 Wetland Functions, Condition, Stressors: Ecologists and managers often describe wetlands according to their functions, condition, and observed anthropogenic stressors. These characteristics are interrelated and are often conflated with each other. However, these characteristics do not have predictable relationships with each other for a single wetland or for sets of wetlands in a landscape.

Wetland functions are those ecosystem services that wetlands provide to support native biota and ecosystem resilience (Mitsch and Gosselink 2000). These include nutrient cycling, floodwater storage, wildlife habitat, drought mitigation, and others. Wetland functions are sometimes confined to those "values" - or ecosystem services - that are particularly valuable to human societies, such as sequestration of carbon and retardation of stream channel erosion.

Wetland functions may be associated with specific wetland types - for example, estuarine wetlands have a particular set of functions which include nutrient retention and habitat for migrating birds. The LLWW wetland classification system (Tiner 2003) is designed to characterize wetland types by their potential functions. Ecologists and managers also measure wetland functions directly - generally with intensive, quantitative protocols directed at a limited number of sites. For example, bird density, number of rare plant populations, or annual net sediment storage could be interpreted as metrics of wetland function.

Wetland condition can represent either ecological integrity (De Leo and Levin 1997) or complexity or a conflation of both. Condition is sometimes conceptualized as the degree of perturbation from a historic state of primitive wholeness - with wetlands deemed in "good condition" reflecting a historic ideal relatively free of human disturbance. However, the conceptualization of "good condition" as historic primitiveness generally assumes that these habitats were subject to little or no human influence before the 18th century - which is unlikely to be a valid assumption in water-limited environments such as California. More recently, wetland condition is often understood as representing a site's biodiversity and complexity - with the assumption that wetlands deemed to be in good condition will support a high degree of native biodiversity and be structurally complex relative to wetlands deemed to be in poor condition. Ecologists and managers often assume that wetlands in good condition are more likely to have high functioning relative to wetlands in poor condition.

However, the relationships between ecological integrity, native biodiversity, structural complexity, and habitat functioning are not necessarily positive or linear: wetlands with very little alteration from a historic state can be biotically and structurally simple and provide few wetland functions. High native biodiversity and structural complexity are attributes of wetlands which are often - although not universally - positively correlated with wetland functions valued by humans. The recently-developed CRAM protocol (Collins *et al.* 2008) is designed to allow field observers to rapidly judge a wetland's native biodiversity and structural complexity in order to assign a semi-quantitative assessment of condition. CRAM metrics have been extensively tested in various habitats with comparisons of assessments conducted by different observers (Clark *et al.* 2006) in order to create a protocol that is resistant to observer bias.

Wetland stressors are generally defined as discernable anthropogenic perturbations of wetland habitats or their environs (Mitsch and Gosslink 2000). These are assumed to negatively affect natural wetland processes and/or biodiversity. Examples of wetland stressors include dams, ditches, adjacent roads and fences, agriculture, and mine runoff. Many field-based wetland assessment methodologies - such as CRAM - ask observers to report the presence/non-detection of a suite of predefined potential stressors on a check-list. In addition some assessment methodologies - for example, the California Native Plant Society Rapid Assessment Method (CNPS 2007) - ask field observers to judge the degree to which the stressor appears to affect the site.

It is reasonable to expect negative relationships between the number and severity of stressors and wetland condition or function. However, studies evaluating two or three of these attributes rarely find strong correlation (*e.g.,* Parsons *et al.* 2004, Adamus and Bartlett 2008). This may be due to a poor human ecological understanding of which stressors are most likely to impair wetland condition and function - for example, although an adjacent road may be the most readily observable potential stressor to a wetland complex, the wetland may actually be more severely degraded by deposition from a power plant several miles away, or by an invasive soil invertebrate. In addition, the lack of a correlation between observed stressors and wetland condition and function may also be due to a poor understanding of thresholds in these relationships - for example, an adjacent road may not appreciably impact wetland condition or functions unless it is more than four lanes wide and carrying more than 100 cars per hour. However, characterizing stressors when assessing wetlands may help managers better understand relationships between individual observed stressors and wetland condition and function in the future.

1.2.3 Riparian Habitats

Some vegetation classification systems broadly define all riparian habitats as "wetlands." However, areas dominated by phreatophytic plants on riverbanks (*e.g.,* willows, alders) sometimes lack the persistent surface or near-surface water regime required for field observers to identify them as wetlands under the Army Corps of Engineers wetland mapping protocol. These areas are also not included in the US Fish and Wildlife Service Cowardin wetland classification system.

However, the USFWS recognizes that - particularly in the arid Western US - non-wetland riparian habitats can be even more critical than rare wetland habitat in preserving landscape-scale biodiversity and watershed functions. Therefore, the USFWS created a definition for riparian habitat to complement the Cowardin classification:

Riparian areas are plant communities contiguous with and affected by surface and subsurface hydrologic features of perennial or intermittent lotic and lentic water bodies (rivers, streams, lakes, or drainage ways). Riparian areas have one or both of the following characteristics: 1) distinctly different vegetative species than adjacent areas, and 2) species similar to adjacent areas but exhibiting more vigorous or robust growth forms. Riparian areas are usually transitional between wetland and upland. (USFWS 1997)

In some locales the USFWS maps riparian areas along with wetlands - primarily via photointerpretation of satellite imagery - for their National Wetlands Inventory.

1.2.3.1 Riparian Habitat Delineation: No commonly-accepted technique or protocol for field-mapping riparian habitat exists (Sutula *et al.* 2006, Collins *et al.* 2006). Riparian systems are often bounded on their lower edge by wetlands and on their upper edge by uplands, but both of these edges may exhibit gradual continua of vegetation composition and density, soil saturation, and persistence of surface or near-surface water. Lower riparian habitat boundaries - between riparian areas and wetlands - may be identified via thresholds defined by wetland delineation protocols (*e.g.*, '87 Manual); however upper boundaries - between riparian and upland habitats - are often so gradual that consistent quantitative thresholds for delineation are impractical.

1.2.3.2 Riparian Habitat Classification: The USFWS classification system for riparian habitat (USFWS 1997), distinguishes between riparian areas associated with streams and rivers (lotic) from those associated with lakes and ponds (lentic). This classification also differentiates between riparian areas dominated by forested, scrub-shrub, and herbaceous vegetation communities, and those dominated by deciduous, evergreen, and mixed deciduous/evergreen vegetation communities (see figure SOP 7.1). Some vegetation classification systems further define and identify plant communities commonly found on stream banks and lakeshores in particular regions (*e.g.*, Holland 1986, Sawyer and Keeler-Wolf 1995) or locales (*e.g.*, Kittel *et al.* 2009).

1.2.3.3 Characteristics of Lotic Riparian Habitat: This protocol seeks to detect ecological changes in lotic (stream-associated) riparian habitat at Pinnacles National Monument. There are no natural lake-associated riparian habitats at Pinnacles NM; these are restricted to less than one acre of lands immediately surrounding the Bear Gulch Reservoir, which are not subject to monitoring under this protocol. Therefore, this section will focus on characteristics of lotic riparian habitat and exclude discussion of lentic (lake-associated) riparian habitat.

The characteristics of individual lotic riparian habitats are inextricably tied to characteristics of their associated streams. Streams are typically described and evaluated by assessment of hydrology, geomorphology, and watershed position. Most evaluations of these attributes result in metrics applicable to a specific section - or reach - of stream channel.

Changes in stream hydrology result in changes in the ability of the stream to support riparian habitat. It is preferable to quantify a stream's hydrology directly by measuring the amount of water carried by the stream during various sizes of floods and at many different positions in the watershed. However, it is usually impractical to quantify flow in more than a few, highly-accessible locations for any study. Furthermore, in the Western US many streams are very difficult to gauge due to their ephemeral flows, high bedload of coarse sediment, and braided or multi-channel structures.

Therefore, hydrologists often evaluate geomorphic features of streams in order to gain understanding of stream hydrology without quantifying flow. Stream width and stream bed substrate size are correlated with the amount and velocity of stream flows - particularly with flows that occur about once every-other year, or bankfull flows. The bankfull flow - associated with the dominant discharge in most streams - creates much of the geomorphic structure of any stream system (Dunne and Leopold 1978); therefore, observed changes in stream width and substrate particle size can indicate long-term changes in stream hydrology and the associated riparian habitat that the stream can support. Geomorphic features can be used to both categorize streams to understand how different stream forms may support different types of riparian habitats and also as response variables to evaluate change over time in stream hydrology.

Riparian areas and their associated stream reaches are also characterized by position in the drainage. This is often described as "stream order" - a categorization which reflects the number of stream confluences between the reach and the headwaters (*i.e.*, how far down the reach is in the stream network). A stream reach's position in the drainage can also be characterized as the extent of land draining to that reach and the stream slope. These watershed position characteristics typically do not change over timeframes relevant for management and are therefore not targets for monitoring. However, they are useful for classifying stream reaches and their associated riparian habitats to assist with analysis of metrics which do change within management-relevant timeframes.

1.3 Watersheds, Streams, and Wetlands at Pinnacles National Monument

Pinnacles National Monument sits in the southern end of the Gabilan Mountain Range in San Benito and Monterey Counties, California (Figure 1.1). The 9,819 hectare (24,265 acre) monument ranges in elevation from 251 m (824 ft) in lower Chalone Creek to 1,007 m (3,304 ft) at North Chalone peak. The monument was established in 1908 by President Theodore Roosevelt to protect the Pinnacles Rocks and associated talus caves.

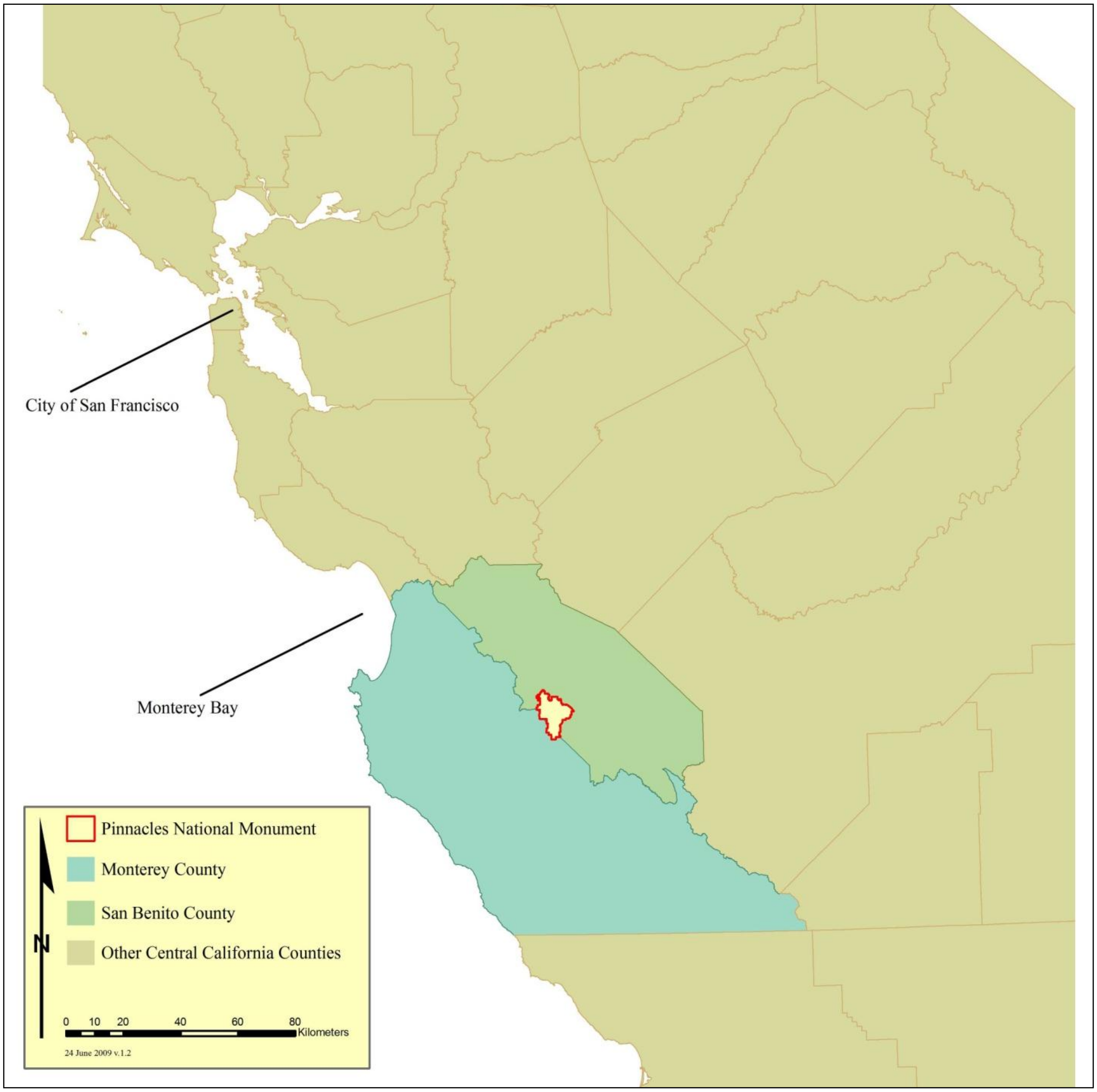

Figure 1.1. Location of Pinnacles National Monument in central California.

The weathered breccia rocks of the High Peaks formation are the remains of one-half of a 23 million-year-old volcano. These rocks have moved northward 322 kilometers (about 200 miles) from the other half - now on private lands near Lancaster, CA - since their emergence. Pinnacles NM is underlain by a complex set of major and minor fault systems - including the San Andreas Fault - which strongly influence the monument's geology and groundwater. The monument's terrain is heavily dissected with canyons; the volcanic ridges typically stand over 300 m (about 1,000 ft) above valley floors.

The monument is subject to the Mediterranean climate typical of central and southern California: summer temperatures regularly exceed 40° C (104° F) with average winter night-time low temperatures hovering just above freezing. In most years all precipitation in the monument falls as rain - the High Peaks receive snow only about once per year. Rainfall is extremely variable - both within each year and between years. Typically most of the monument's precipitation arrives between October and April. Within the historic record - between 1937 and 2009 - the monument has received as little as 15.5 centimeters (6.1 inches) and as much as 90.9 centimeters (35.8 inches) of rain in one year (1947 and 1982, respectively) (Table 1.1, WRCC 2009; the weather station is located within the monument off of Highway 146 east near the turnoff to the Chalone Creek picnic area).

Table 1.1. Average monthly maximum and minimum temperatures and precipitation at Pinnacles National Monument for the years 1937–2009.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Max. Temperature (F)	61	63	66	72	80	88	96	95	91	81	69	62
Average Min. Temperature (F)	33	35	37	39	43	47	50	50	48	43	37	33
Average Total Precipitation (in.)	3.2	3.1	2.9	1.3	0.4	0.1	0	0.1	0.2	0.7	1.7	2.8

Two public roads lead into the monument: Highway 146 East follows Sandy Creek then splits to its termini near the Bear Gulch Nature Center area and at the Chalone Creek Picnic Area. Highway 146 West affords access to the Chaparral Picnic Area (Figure 1.2). The monument maintains over 41 kilometers (over 25 miles) of trails, many built by the Civilian Conservation Corps in the 1930s. The monument currently supports three visitor contact stations and contains two private inholdings within its boundary (Figure 1.2).

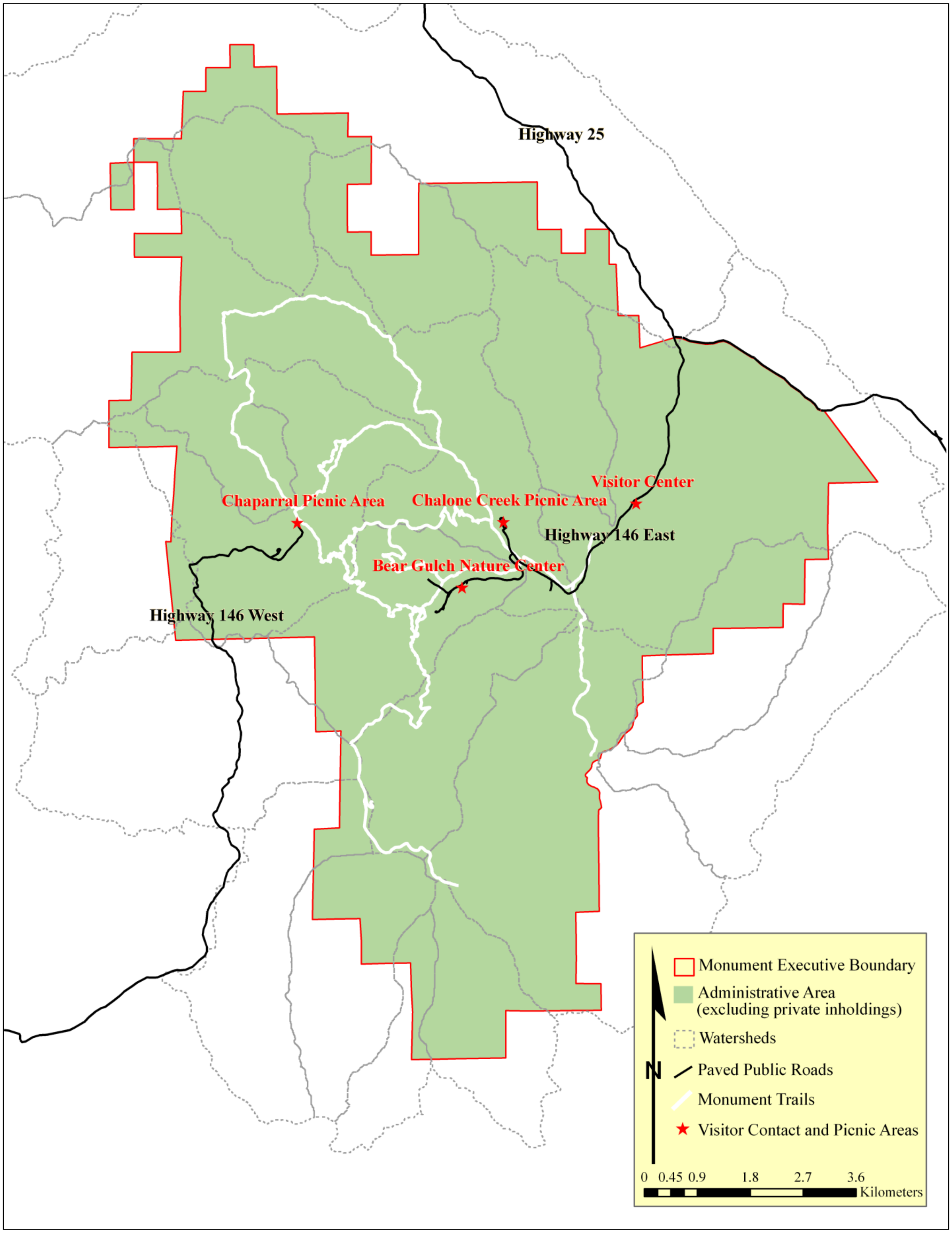

Figure 1.2. Pinnacles National Monument boundary, public roads, trails, visitor contact and picnic areas, and watershed boundaries.

The monument's largest drainage is Chalone Creek (Figure 1.3), which flows out of La Gloria Valley immediately west of the monument, then east and south through the monument. Chalone Creek receives the waters of most of the monument's other catchments, including Lost Canyon, Marion Canyon, Bear Gulch, Frog Canyon, McCabe Canyon, and Sandy Creek. After leaving the monument, Chalone Creek - influenced by the complex tectonic fault system underlying the region - flows south and then west again to meet with the Salinas River in the Salinas Valley. Several catchments with headwaters in the monument do not flow to Chalone Creek, but drain directly west to the Salinas River without first entering Chalone Creek. Lands included in these watersheds constitute only 5% of the monument's total area. Waters from the Salinas Valley drain north, then west, to the Pacific Ocean at Monterey Bay.

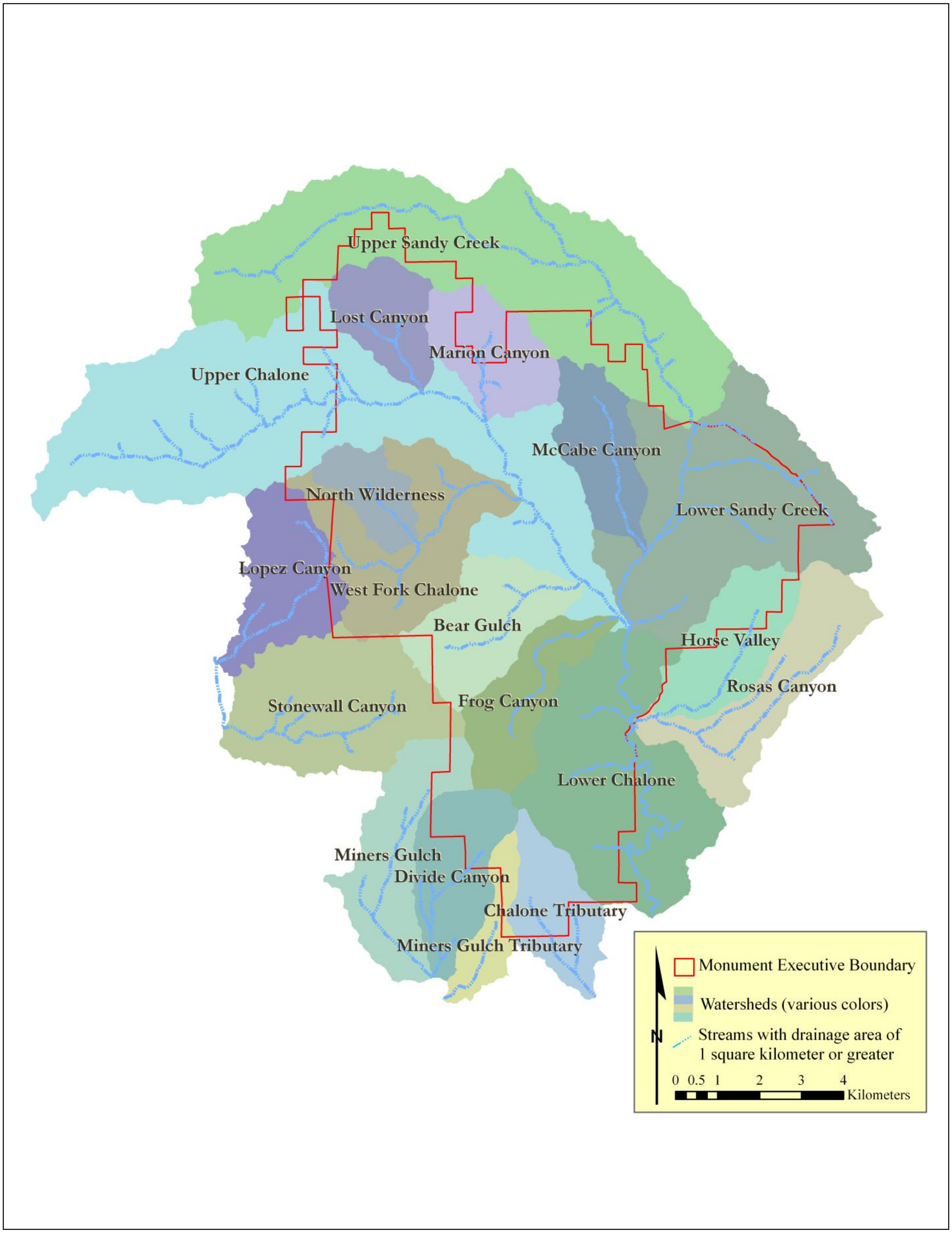

Figure 1.3. Watersheds of Pinnacles National Monument and streams with drainage areas of 1-square kilometer or greater.

Pinnacles NM contains 19 watersheds (Table 1.3) of three square kilometers or greater. Three of these watersheds fall entirely within monument boundaries: Frog Canyon, McCabe Canyon, and North Wilderness; a fourth watershed, Lost Canyon, falls almost entirely (99.8%) within the monument boundary.

Table 1.2. Names and extent (in square kilometers) of watersheds at Pinnacles National Monument.

Watershed Name	Total Area	Area In Monument	% Of Watershed in Monument
Upper Chalone	39.94	17.63	44.1%
Upper Sandy Creek	34.72	4.85	14.3%
Lower Sandy Creek	23.39	17.20	73.8%
Lower Chalone	20.36	13.40	66.4%
Stonewall Canyon	14.07	0.43	3.1%
West Fork Chalone	11.56	11.10	96.9%
Rosas Canyon	9.57	0.02	0.2%
Miners Gulch	8.90	0.88	10.1%
Bear Gulch	8.21	7.63	93.2%
Lopez Canyon	7.90	0.65	8.2%
Horse Valley	7.28	2.64	36.5%
Divide Canyon	7.27	2.64	36.6%
Marion Canyon	6.64	5.00	75.3%
Frog Canyon	6.60	6.60	Entire
McCabe Canyon	6.17	6.17	Entire
Chalone Tributary	5.86	3.43	59.3%
Lost Canyon	5.30	5.29	99.8%
North Wilderness	3.74	3.74	Entire
Miners Gulch Tributary	3.13	0.94	30.1%

Pinnacles NM supports two primary types of wetlands: wetlands associated with springs and seeps and not in stream channels and wetlands found in stream channels. Wetlands associated with springs and seeps at Pinnacles NM are assumed to be relatively permanent and supported by water stored for decades in rock fissures and permeable geologic strata (Borchers and Lyttge 2006). These systems are heavily influenced by the amount of stored water emerging at the land surface, which can change suddenly with tectonic action, or remain stable for decades (Borchers and Lyttge 2006; Babalis 2009). Water abundance and chemistry of these springs is predominantly associated with the monument's complex geology.

Water abundance can also be influenced unpredictably by local or distant water extraction. Nearby or even distant wells for municipal or agricultural water can tap fossil aquifers that may feed monument springs. These aquifers store water from rainfalls that occurred decades or centuries earlier. Springs that are surface expressions of these old-water aquifers can be highly sensitive to extraction; these aquifers often cannot recharge at the rate of extraction and so are non-renewable resources. Also, withdrawal of even a small fraction of the aquifer's total volume can disproportionally impact springs by lowering the elevation of the top of the aquifer to below the outlet of the spring (Dunne and Leopold 1978).

The other predominant type of wetland at Pinnacles NM is found within the stream channel; these are fed by groundwater or surface water or a combination of both. They can be relatively permanent in location - particularly when downgradient of a spring or seep that provides year-round and interannually-stable flows. Alternatively, in-stream wetlands can be relatively ephemeral if fed by primarily surface water and near-surface groundwater from recent rains. These often wash out and reform elsewhere in the channel bed due to moderate or larger flood flows (Johnson 2009). At three locations at Pinnacles NM permanent water impoundments detain stream flows to create permanent and semi-permanent surface water: at Bear Gulch Reservoir, at the Sandy Creek Tributary Stock Pond, and at an unnamed stock pond in upper Horse Valley.

Riparian habitat at Pinnacles NM typically supports sparse vegetation due to the arid climate, however in some reaches dense stands of shrubs or shrubby trees can form impenetrable thickets covering short lengths along the channel. Tree species in the channel and on the floodplain include native oaks (*Quercus agrifolia, Q. douglasii, Q. lobata and Q. wislizenii*); foothill pine (*Pinus sabiniana*), California juniper (*Juniperus californica*); holly-leaf cherry (*Prunus ilicifolia*); California sycamore (*Platanus racemosa*); Fremont and black cottonwood (*Populus fremontii and P. balsamifera ssp. trichocarpa*); and several species of willow (*Salix laevigata, S. exigua, and S. lasiolepis*). Shrubs are often more abundant than trees in the riparian corridor and include poison oak (*Toxicodendron diversilobum*); mule-fat and coyote brush (*Baccharis salicifolia and B. pilularis*); and wild rose (*Rosa californica*) (NPS 2009).

Native wildlife commonly found in the streams and riparian areas at Pinnacles NM includes three-spined stickleback (*Gasterosteus aculeatus*); Pacific tree frog (*Pseudacris regilla*) and California red-legged frog (*Rana draytonii*); common gartersnake (*Thamnophis sirtalis*); passerine birds such as house wren (*Troglodytes aedon*), black phoebe (*Sayornis nigricans*), yellow-breasted chat (*Icteria virens*), and lazuli bunting (*Passerina amoena*); as well as raptors such as Cooper's hawk (*Accipiter cooperii*), sharp-shinned hawk (*A. striatus*), and long-eared owl (*Asio otus*). Native mammals frequenting riparian corridors at Pinnacles NM include black-tailed deer (*Odocoileus hemionus*), raccoon (*Procyon lotor*), Western brush rabbit (*Sylvilagus bachmani*), and several species of bat. The streams and their floodplains are also habitat for a great diversity of invertebrates - both aquatic and terrestrial - including damselflies and dragonflies; bees and wasps; moths, butterflies, and spiders (NPS 2009).

Although the core lands of Pinnacles NM have been protected as a National Monument for over a century - and therefore have been relatively protected from introductions of non-native species - the monument harbors non-native plant and animal species. In addition, the monument has recently expanded to include former ranching lands that support more non-native plant species than the core lands, both due to their landscape position in the valley bottoms and their management history. Many non-native species are so abundant and well distributed throughout the monument that they are not targets for active management. Some species, however, are noxious habitat-altering organisms that are, or may be, targeted by managers for removal. These include wild pig (*Sus scrofa*), green sunfish and bluegill (*Lepomis spp*.), bullfrog (*Rana catesbeiana*), yellow star-thistle (*Centauria solstitialis*), Himalayan blackberry (*Rubus discolor*), and horehound (*Marrubium vulgare*) (NPS 2009). Crayfish (various genera) are not currently found within the monument but have a potential to invade from nearby lands (Johnson 2009).

1.4 Linkages among This and Other Monitoring Projects

This protocol is independent and may be implemented without reliance on any other efforts. However, the protocol does have linkages to other monitoring and assessment programs, as shown below.

1.4.1 California Rapid Assessment Method for Wetlands (CRAM)

The CRAM protocol (Collins *et al.* 2008) - modified for California from the Ohio Rapid Assessment Method (Mack 2001) - is designed to allow observers to record structured observations about a wetland in a short amount of time, and provides a mechanism for summarizing those observations to broadly characterize the condition of the wetland. This tool provides more information about the structure and condition of a wetland than standard wetland delineation and classification protocols can. CRAM (www.cramwetlands.org) was developed by the San Francisco Estuary Institute and the Southern California Wetlands Recovery Project for use in evaluating wetlands throughout California from urban to Wilderness lands. CRAM is becoming a commonly-used rapid assessment tool for federal, state, and local agencies and non-governmental organizations operating in California.

This Pinnacles wetlands monitoring protocol draws on some of the rapid-assessment metrics designed and rigorously tested by CRAM developers. Some CRAM metrics are too coarse for change-detection, even on long time frames, and are more appropriate for one-time site assessments. However, some CRAM metrics allow observers to quickly evaluate site characteristics which may change over time, providing relevant information to managers. The CRAM protocol is currently in Version 5.0.2, and the rate of changes to the CRAM protocol has slowed considerably with each new version. However, future changes are possible.

Unlike CRAM - which has the primary function of providing a one-visit assessment, and a secondary goal of providing a framework for monitoring - this SFAN protocol is designed for change detection. Therefore, it is recommended that future authors and users of this SFAN protocol do NOT update this protocol if/when the CRAM protocol is altered, unless CRAM authors or others find that one or more CRAM metrics employed in this SFAN protocol inaccurately reflect wetland conditions. Continually mirroring CRAM's protocol may render change-detection with its metrics infeasible.

1.4.2 Network Weather and Climate Monitoring

The San Francisco Bay Area Network assembles data on weather and climate from park and non-NPS sources. These data are used when interpreting the results of network monitoring programs, such as this riparian and wetlands monitoring program.

1.4.3 Network Early Detection Protocol for Invasive Non-Native Plant Species

This Pinnacles riparian and wetlands monitoring protocol asks users to collect a limited amount of data to supplement the San Francisco Bay Area Network's early detection (ED) program (Williams *et al.* 2009). Data collected during this effort will be delivered to ED program managers for analysis, storage, interpretation, and recommendations for management response. Before each field season, managers for the Pinnacles wetland monitoring protocol will consult with ED program managers to update the wetlands data collection procedures in order to best serve the ED program's needs (see SOP 8). Some of the more likely changes will be additions and deletions of targeted Early Detection species from this Pinnacles wetland monitoring protocol's Weed Watch List and changes to the reporting procedures.

1.4.4 Network Plant Community Change Protocol
This Pinnacles wetlands monitoring may share metrics, sampling locations, personnel, equipment, and/or operating procedures with the San Francisco Bay Area Network's plant community change protocol. Data collected through implementation of this Pinnacles wetlands protocol will likely provide relevant information for evaluating overall change in vegetation communities in the monument. However, the plant community change protocol is in early draft; specific commonalities will be discussed in this section as they are identified.

1.4.5 Network Raptor Monitoring Protocol
There are no commonalities between the network's raptor monitoring protocol for Pinnacles NM and this wetlands monitoring protocol.

1.4.6 Network Amphibian Monitoring Protocol
This wetlands monitoring protocol may share sampling locations and/or operating procedures with the San Francisco Bay Area Network’s protocol for tracking changes in stream-breeding amphibians at Pinnacles NM. However, the amphibian monitoring protocol is in draft; specific commonalities will be discussed in this section as they are identified. The network is also planning to track changes in abundance of pond-breeding amphibians at the monument; there is no overlap with this wetlands monitoring protocol.

1.4.7 Network Streamflow and Water Quality Monitoring Protocols
Although there is no direct commonality (*e.g.*, common SOPs, equipment, staff) between this wetlands monitoring protocol and streamflow and water quality monitoring (Cooprider and Carson 2006) at Pinnacles NM, collection of water quantity, water quality, and wetlands abundance provides an integrated view of the status of surface waters at the monument. This wetlands monitoring protocol will detect changes in the abundance of early-summer surface water at a landscape scale. Long-term changes in riparian vegetation may imply changes in hydrology. Trends observed in abundance of wetlands and structure of riparian plant communities may be correlated with streamflow data from the network's stream gages on Bear Gulch and Sandy Creeks. Changes in water quality parameters monitored on Chalone Creek, Sandy Creek, Bear Gulch, and in McCabe Canyon may also be correlated with streamflow and wetland characteristics. However, no specific comparisons are planned.

1.4.8 Network Landbird Monitoring Protocol
This wetlands monitoring protocol may share sampling locations and/or operating procedures with the San Francisco Bay Area Network’s protocol for monitoring landbirds. The landbird protocol has not yet been fully developed for Pinnacles NM, but may include quantitative monitoring of birds in the riparian corridors with point-count methodologies (Gardali *et al.* 2010). Data from the landbird protocol may be evaluated along with data from riparian and wetland monitoring at Pinnacles. However, at this time no specific comparisons are planned.

1.5 How Monitoring Results Will Inform Management Decisions

This wetlands and riparian monitoring protocol seeks to detect changes in habitat that is critical for a portion of the monument's biological community - including most of its vertebrate fauna. At this time, the greatest risks to these habitats (and associated biota) appear to be reductions in abundance of wetlands and reductions in extent and structural complexity of riparian vegetation communities. Individual in-stream wetlands or reaches of riparian habitat may be locally degraded by natural disturbances such as flood, wind, and rockfall, but biota will adapt in both the short and long term - as long as the abundance and quality of habitat is not degraded across the entire monument or across entire watersheds.

At this time, it appears that potential reductions in habitat extent or complexity at a landscape scale would most likely be a result of introduction and spread of non-native invasive plants, changes in temperature and precipitation regimes at Pinnacles NM, and/or tectonic activity. Other possible stressors include changes in use of lands and waters upstream of Pinnacles National Monument - upstream either via the evident surface stream system or via the poorly-understood rock aquifer system underlying the monument. Upstream changes in land use may degrade wetlands and riparian habitats at Pinnacles NM through water extraction, water contamination, deposition of air-borne pollution, and introduction and spread of invasive non-native plants and animals. Trends in the wetland abundance and/or riparian vegetation structure may indicate anthropogenic influence from nearby stressors that monument staff may be able to mitigate, such as intense human use adjacent to wetlands. This monitoring effort can provide an early warning of changes in wetlands and riparian habitats in the monument due to changing uses of neighboring lands, which will allow monument managers to respond administratively to protect monument resources and focus additional studies on observed trends.

Monument managers will benefit from understanding trends in wetland and riparian habitat extent and complexity: this understanding will allow NPS employees to make better decisions regarding management of wetland-dependent species, identify any opportunities for local or off-site mitigation, and respond to as yet unknown threats to these important habitats.

1.6 Thresholds and Trigger Points for Management

This protocol does not track a single univariate metric to show the status of a monument resource, such as is commonly done for monitoring of valued species, where a fall in abundance may trigger management when clear management options exist.

A review of relevant literature suggests that there are no commonly-accepted quantitative thresholds for abundance of wetlands, amount of riparian cover, or channel characteristics. There are also no commonly-accepted or experimentally tested thresholds for acceptable decline in wetland abundance or riparian structure or change in channel morphology. This protocol gathers multiple lines of evidence - concerning trends in abundance of surface and near-surface water as indicated by prevalence of wetlands, trends in riparian vegetation community metrics, and trends in basic channel morphology characteristics - to illuminate landscape-scale changes over long timeframes (*i.e.,* more than ten years). Furthermore, degradation due to changes in hydrologic and temperature regimes are not mitigated by local management changes.

However, managers at Pinnacles NM determined, based on their knowledge and experience of the monument and its biota, appropriate thresholds to trigger management response.

Objective 1: any decline of ≥ 25% relative frequency of wetland abundance in 100-meter reaches of stream channels at Pinnacles NM from baseline conditions (represented by the first full year of protocol implementation) OR any decline of 35% in any one of the 10 watersheds surveyed by this protocol will trigger management response. The management response will be investigation into the cause and potential effects of the decline in wetland abundance, seeking of funding for research if necessary, and formulation of management response to protect valued biota that may be affected by the decline.

Objective 2: any statistically-significant change of 25% or greater in the foliar cover of any guild of riparian cover monitored by this protocol from baseline conditions OR any statistically-significant change of 35% in any guild in any one watershed will trigger management response. The management response will be investigation into the cause and potential effects of the change in riparian vegetation, seeking of funding for research if necessary, and formulation of management response to protect valued biota that may be affected by the change.

Objective 3: any statistically-significant change of 15% or greater in either the channel bankfull widths across the monument or channel substrate size OR any statistically-significant change in these metrics of 25% in any one watershed will trigger management response. The management response will be investigation into the cause and potential effects of the change in channel morphology, seeking of funding for research if necessary, and formulation of management response to protect valued biota that may be affected by the change.

For the purposes of this monitoring protocol, statistical tests must result in P values of 0.10 or less in order to conclude that a statistically-significant change has taken place (*i.e.*, there is a less than 10% chance that the conclusion was reached erroneously through sampling bias). This threshold was chosen – rather than the more typical 5% threshold – because the cost of not taking action when a detrimental change is truly underway is deemed highly undesireable, wheras taking a 10% risk that management action will be triggered when truly no change is underway (i.e., concluding that a change has taken place when it actually has not) was deemed an acceptable risk by park managers.

In addition, when considered with data from other monitoring efforts - such as those monitoring streamflow, water quality, amphibians, vegetation communities and landbirds - will provide managers with information about the overall changes ecosystems within the monument (see Table 1.3). This ecosystem monitoring strategy does not lend itself to establishment of quantitative trigger points for management, but nevertheless provides important information for managers about trends in monument streams and other habitats.

Data from this monitoring program will inform managers about the presence and location of habitat-damaging non-native invasive plants and animals so that monument staff can eradicate early threats before they become unmanageable. These data will be provided to the network Early Detection program for invasive species and the Pinnacles NM Wildlife Biologist (see SOP 8) for prioritization and identification of appropriate treatment. Data gathered by this effort will be analyzed by watershed, which may illuminate effects of distant water withdrawal; although, showing a causal relationship between water withdrawal and resource alteration may not be feasible. Also, data from this effort will inform managers about local stress on riparian systems due to visitor use (*e.g.*, trampling, littering) that can be directly mitigated.

Table 1.3. Multiple lines of evidence to indicate ecosystem change in stream systems at Pinnacles NM.

Data Source	Further Description	Data
Protocol Objective 1	Sections 1.1 and 2.2.2.1	Changes in abundance of stream-associated wetlands
Protocol Objective 2	Sections 1.1 and 2.2.2.2	Changes in riparian vegetation - foliar cover by guild, foliar cover of tree and shrub species, guild richness
Protocol Objectives 3	Sections 1.1 and 2.2.2.2	Changes in stream morphology (average stream width, average substrate size)
Protocol Ancillary Data	Section 2.2.2.3	Changes in vegetation communities in the floodprone area and dominant plants by plant layer in the bankfull channel
Protocol Ancillary Data	Section 2.2.2.3	Changes in Rosgen stream type
Protocol Ancillary Data	Section 2.2.2.3	Changes in rapid-assessment metrics for streams (buffer condition, channel stability, structural patch richness, topographic complexity, horizontal interspersion and zonation, and vertical biotic structure)
Network Weather and Climate Monitoring Protocol	Section 1.4.2	Changes in precipitation
Protocol Ancillary Data and Network Early Detection Protocol	Sections 2.2.2.3 and 1.4.3	Changes in invasive plants and animals in stream corridors
Network Stream-breeding Amphibian Monitoring Protocol for Pinnacles NM	Section 1.4.6	Changes in stream amphibian distribution in stream corridors
Network Streamflow Monitoring Protocol	Section 1.4.7	Changes in streamflow
Network Water Quality Monitoring Protocol	Section 1.4.7	Changes in water quality
Network Landbird Monitoring Protocol	Section 1.4.8	Changes in bird abundance in riparian habitat

2 - Data Collection Design

2.1 Rationale for Selection of Data Collection Design

2.1.1 Rationale for Rejecting Other Commonly Used Designs

Monitoring wetland abundance can be difficult in arid environments. Because these wetlands are very rare relative to the overall land surface, simply placing a random grid of points on the landscape and assessing each point for wetland presence/condition results in inefficient fieldwork and limited data.

Some wetland monitoring programs draw sampling locations from areas identified as wetlands on National Wetland Inventory (NWI) wetland maps. However, these maps generally have high rates of omission and commission, and are not designed to provide an unbiased portfolio for sample design. NWI maps for Pinnacles NM do not form an adequate frame for choosing samples. Some researchers have improved the local accuracy of NWI maps through incorporating additional data - such as geology maps, elevation models, vegetation maps, soils maps (*e.g.*, Adamus and Bartlett 2008); these efforts have not been systematically evaluated for their utility in providing a base layer for drawing an unbiased sample of wetlands in a landscape.

Protocols based on samples from existing wetland inventories tend to oversample some types of wetlands, such as large wetlands, and completely overlook others, such as small wetlands, hillslope wetlands, and wetlands under tree canopy. Furthermore, protocols based on data collection within specific wetland polygons risk increased bias over time if sampling locations are permanent; some sample units may convert to upland over time, while other nearby (un-sampled) areas may obtain wetland characteristics. Alternatively, designs with temporary sampling units - requiring users to create a new set of sample points or polygons before each field season - necessitate frequent updates of wetland inventories from remotely-sensed data, which is generally infeasible.

2.1.2 Rationale for Choosing the Proposed Data Collection Design

Pinnacles National Monument supports two primary types of wetlands - wetlands associated with springs and seeps and not in stream channels and wetlands found in stream channels (see Chapter 1). Monitoring wetlands associated with springs and seeps at a landscape scale at the monument may best be served by monitoring the quantity and chemistry of the water supporting these wetlands, alongside monitoring of springs and seeps that do not have dependent wetlands (as found in Borchers and Lyttge 2006). A program designed to help managers understand trends in these systems would require different personnel expertise, equipment, sampling return interval, and protocol, and is not covered by this document. Alternatively, monument staff may wish to design site-specific monitoring programs to track the condition of individual springs that are of high management concern, such as those found in McCabe Canyon and at Willow Spring; site-specific monitoring for individual wetlands of management concern is also not addressed in this protocol.

A second type of wetland at Pinnacles NM - those associated with stream channels - can be efficiently monitored via a landscape-scale survey of all wetlands in appropriate stream channels. Due to the relatively small size of the monument and accessible stream channel system this is feasible to accomplish at the monument. An appropriate sampling frame is all reaches of stream channel within the monument that have a strong propensity to support wetland and/or riparian habitat. With the channel network identified as the sample frame and with wetland abundance, riparian vegetation characteristics, and channel morphology designated as variables that may change over time within that channel network, this design can track changes in wetland abundance and riparian structural characteristics over time without bias.

Stream-associated wetlands can be relatively permanent or ephemeral depending on water source, substrate, and topographic position. However, current data at Pinnacles NM (generally) does not allow for distinguishing relatively permanent, deep ground-water fed wetlands in stream channels from more ephemeral near surface-water dominated wetlands. Therefore this protocol will not attempt to characterize these wetlands by permanence, although data from this protocol will help managers to make this distinction in the future, if desired.

2.2 Site Selection, Target Population, Data Collection Framework, Data Collection Units, and Metrics

The primary target population for data collection is all 100-meter-long reaches within 47 kilometers of stream corridor at Pinnacles NM that have an upgradient catchment basin 3 square kilometers or greater. One third of these reaches will be evaluated each year for quantitative metrics to track changes in riparian vegetation and channel morphology. Data will be collected for the entire target stream network once every third year.

Table 2.1. Summary of data to be collected at multiple spatial scales along the stream channels

Spatial Scale	Data
25-meter segment	Presence or absence of wetlands in segment (Objective 1)
100-meter reach	Vegetation community
	Dominant plant species
	CRAM-derived rapid-assessment metrics
	Rosgen channel type
	Weed- and wildlife-watch species
Transect at 300-meter intertervals	Vegetation guilds sampled along transect (Objective 2)
	Substrate size sampled along transect (Objective 3)
	Bankfull width (Objective 3)

2.2.1 Site Selection, Target Population, Data Collection Framework, and Data Collection Units

Site selection: sites for data collection will be located in the field within the stream channels at Pinnacles National Monument.

Target population: the primary target population is the entire set of all 100-meter reaches within the stream channels that have catchment areas of greater than 3 square kilometers. A secondary target population is a set of permanently-located cross-channel transects positioned appoximately 300-meters apart in the stream system.

Data collection framework: the data collection framework is the area between bankfull banks wihtin stream channels at Pinnacles National Monument that have catchments of 3 square kilometers or greater.

Data collection units: data collection units include both the 100-meter reaches and the cross-channel transects.

Data are collected within stream channel reaches for all reaches that have a catchment basin of greater than 3 square kilometers (Figure 2.1). This 3-kilometer threshold was chosen in order to encompass both those areas that currently have a canopy of woody riparian species - *i.e.*, phreatophytic riparian habitat - and some areas above that in the drainage which do not, at present, support a riparian vegetation community. This design allows data to reflect either expansions or contractions in riparian habitat, and allows for efficient data collection and management by limiting observations to the lower reaches of each watershed - where riparian vegetation is now present or potentially present in the foreseeable future. This threshold for catchment area results in a network of 47 stream kilometers (based on analysis of a 2006 Digital Elevation Model of the monument, see SOP 6 for details regarding DEM manipulation).

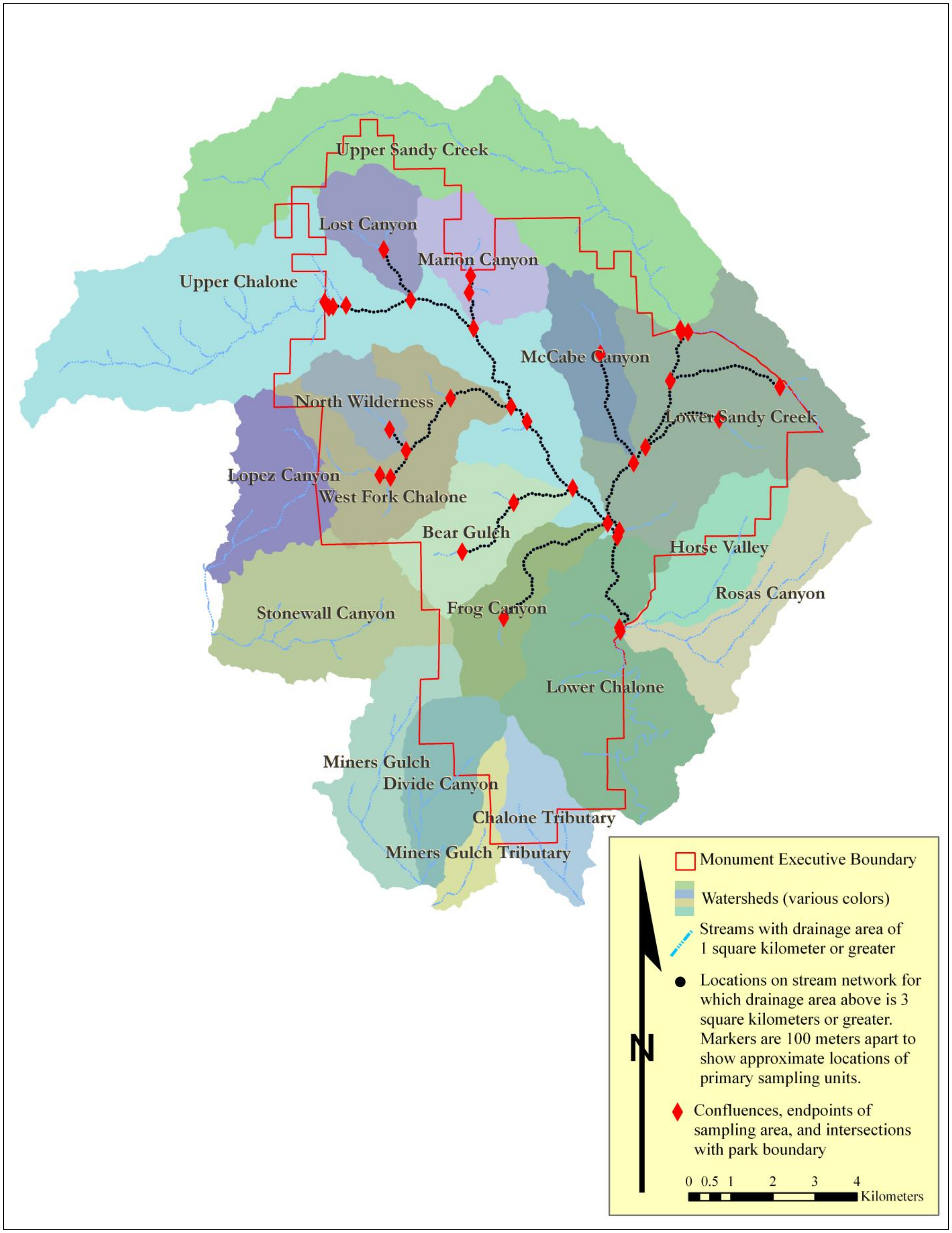

Figure 2.1. Approximate locations of primary sampling units (black circles) and stream confluences, endpoints of sampling area, and intersections of stream network with monument boundary (red diamonds).

Data collection within the stream network occurs at three spatial scales: 1) the primary sample frame is the complete set of 100-meter long reaches of channel, bounded by the bankfull banks of the channel and the active floodprone area (see SOP 6 for methodology for delineating 100-meter reaches) 2) These reaches are further subdivided into 25 meter long segments for collection of some data, including wetland abundance. 3) Finally, every third 100-meter reach contains a transect oriented perpendicular to the center of the channel between bankfull banks for collection of more intensive quantitative information. The length of each transect will vary by bankfull width of the stream at the transect location.

Data collected in the 100-meter reaches will be identified by stream channel. The data collection frame includes 12 streams (Table 2.1). These streams will accommodate between 7 (North Wilderness) and 115 (Upper Chalone) 100-meter reaches, depending on stream length. In addition the streams will accommodate between 3 and 39 transects. In some cases, where the number of 100-meter reaches is not a multiple of three, streams may receive one fewer transect than listed on Table 2.2, depending on which reach the transect is randomly and permanently located in (see section 2.2.1.3).

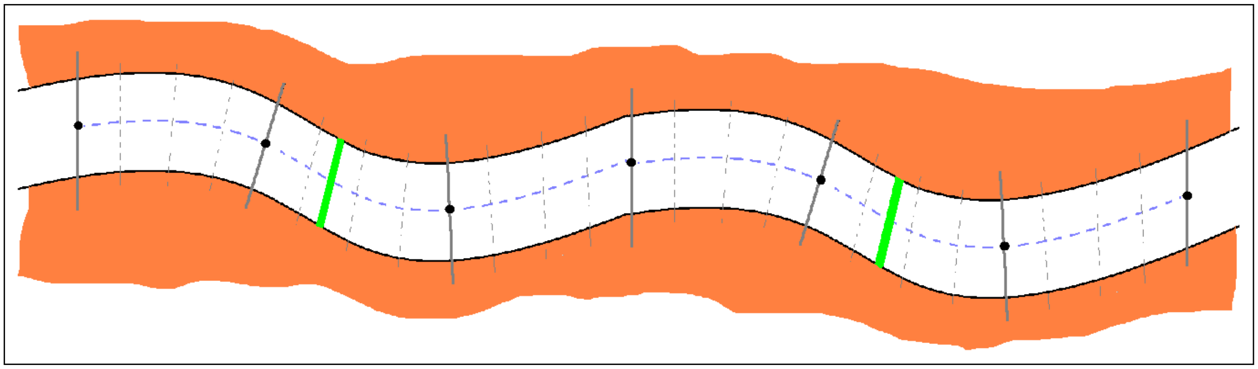

Figure 2.2. Framework for data collection within stream channels at Pinnacles National Monument. Gray bars denote ends of 100-meter reaches, measured along the channel center (dashed blue line), with black circles as the downstream beginning point for each reach. 100-meter reaches are divided into 25-meter segments (dashed gray lines). One in every three reaches includes a transect (green line). Data are collected within the bankfull banks of the stream (black lines) and within the floodprone area (orange area).

Table 2.2. Streams included in the data collection frame.

Stream name	Parent watershed	Number of 100-meter reaches in the data collection frame	Maximum potential number of transects
Bear	Bear Gulch	38	13
Frog	Frog Canyon	45	15
Lost	Lost Canyon	16	6
Lower Chalone	Lower Chalone	32	11
Marion	Marion Canyon	15	5
McCabe	McCabe Canyon	31	11
Middle Chalone	Middle Chalone	49	17
Nassella	Lower Sandy Creek	31	11
North Wilderness	North Wilderness	7	3
Regan	Lower Sandy Creek	23	8
Sandy	Lower Sandy Creek	64	22
Upper Chalone	Upper Chalone	115	39

2.2.1.1 100-meter Reaches: Data are primarily collected within 100-meter reaches. This reach length is short enough to allow observers to evaluate the entire reach - and therefore be able to characterize vegetation and habitat condition parameters for the entire reach. The reach length is long enough to allow observers to move quickly enough through the watershed that a team of two observers will be able to complete data collection in 10 weeks each data collection year (see section 6.4 for budget). This estimate of the amount of time that will be required for completion of one year of implementation is based on 2009 pilot data collection.

Data recorded for the primary sample units are channel width, vegetation community (according to the Pinnacles NM vegetation classification system), dominant plant species and their absolute cover (see SOP 5 for protocols for identifying dominants), and CRAM-derived rapid assessment metrics.

The 100-meter long reaches are not permanently marked, but will be positioned each data-collection season, in order to accommodate channel evolution. Observers start at a geomorphically-determined downstream point of each stream, then 100-meter reaches are measured upstream from the start point in the field sequentially.

2.2.1.2 Twenty-five-meter Segments: Observers will subdivide the 100-meter reaches into 25-meter segments, and note the presence or absence of wetlands within the bankfull banks of each of those segments. For this protocol "wetlands" are defined as areas of any size with a preponderance of wetland plants and indicators of wetland hydrology (USACOE 2008, Environmental Laboratory 1987) (See page 5.10 for greater detail). Indications of wetland soils will not be utilized, as virtually all of the wetlands between the bankfull banks at the monument lack developed hydric soils due to frequent fluvial scour. Observers will estimate the amount of channel occupied by wetland - by size class - and also note the Cowardin wetland type.

2.2.1.3 Permanently-located Transects at 300-meter Intervals: Every third 100-meter reach will contain a permanently-positioned cross-channel transect for collection of quantitative data for channel substrate and riparian canopy. From the first set of three reaches in each stream field observers will assign - based on a random draw - which reach will receive a transect; then every third subsequent reach will receive a transect. This density of samples will 1) allow for efficient data collection, and 2) allow for detection of trends in substrate and riparian canopy cover for each stream (see section 2.6). Within these "transect" reaches, a random location will be chosen in the field along the channel center. Transects will run perpendicular to the channel center between bankfull points on the bank, and observers will collect substrate size characteristics and canopy cover data at 20 to 30 points along the transect (number of points dependent on channel width). These data will be averaged for the transect (Bunte and Abt 2001, Elzinga *et al.* 1998). The center point for the transect will be recorded with a GPS unit, and re-located in subsequent years via GPS navigation.

Within each 300-meter-long reach of stream the spatial variability is great enough to warrant permanently-positioned samples for transects (as opposed to re-randomizing the position of the transect each year). Re-locating transects with GPS will not allow observers in future years to relocate transects as precisely as they could if transect endpoints were physically marked in the field (*e.g.,* with buried rebar markers and/or tree tags). However, observers will be able to re-locate the point within +/-1 meter with current GPS technology (Trimble Geo XH and beacon). Even with physically-marked endpoints, observers would encounter random variability in foliage and substrate observed at specific points along each transect. Conditions within several meters of the transect are adequately similar that true changes over time in the canopy or substrate will not be masked by the imprecision of relocating transects via GPS. Establishing permanent markers, documenting the location of permanent markers, and relocating of those markers is both highly time consuming and impractical for the monument's dynamic stream system. This protocol focuses on collecting many data to evaluate change at a landscape scale rather than investment in precision relocation of fewer transects.

This design creates a framework of approximately 466 100-meter reaches for semi-quantitative rapid-assessment data collection and 155 transects for more intensive quantitative data collection. The exact number of 100-meter long reaches may vary due to channel length evolution. Some reaches and transects may not be accessible for data collection due to dangerous vegetation (*e.g.,* dense poison oak or impenetrable riparian forest), deep water as at Bear Gulch Reservoir, streams overtopped by talus, or other hazards (see SOPs 2 and 5). Based on pilot field data and reconnaissance, these are anticipated to be less than 2% of the total number of potential transects and 100-meter reaches.

All reaches will measure 100 m along the channel center; however the width of each unit will vary by stream size across the monument. Variable size of these units will not present a problem for data analysis for two reasons: first, for comparison between years, an assumption is made that average stream channel size will not alter greatly over time across the landscape at Pinnacles NM, even though individual reaches may change in width as the channel evolves over time - unless precipitation patterns and/or riparian vegetation structure change substantially, stream geomorphology at a landscape-scale should not change over time. If mean channel width is changing over time at the monument, then wetland condition estimates can be obtained for reaches with similar widths using post-stratification. Trends in wetland abundance and riparian vegetation structure may also be examined within classes of channel width to determine if these wetland measures are changing at different rates (Starcevich 2009). Second, for summarization of each year's data, the purpose of the measurements is to describe wetland abundance and riparian vegetation structure within the channel network. This goal would not be accomplished by defining a single data-collection frame size (*e.g.*, all data collected for wetlands and plants within 10 m of the channel center) and applying it to all channels within the monument.

2.2.2 Metrics

This protocol seeks to track wetland abundance, riparian vegetation community structure, and channel morphology characteristics.

2.2.2.1 Wetland Abundance (*Protocol Objective 1*): Determine trends in the abundance of wetlands associated with stream channels at Pinnacles National Monument.
Declines in wetland abundance may indicate a degradation of plant and wildlife habitat due to declining water tables, changing temperature or climate regimes, or flood and scour regimes.

Wetland abundance will be quantified by characterizing the percent frequency of wetlands within each quarter of the 100-meter stream reaches (Figure 2.3). That is, overall Pinnacles NM will have a numerical percent frequency of wetlands in stream segments (*e.g.*, 60% of the 25-meter segments may support a wetland). Wetlands will be characterized by Cowardin type (see SOP 7 for classification), and abundance data can be summarized by wetland type: for example, 20% of the 25-meter segments may support palustrine emergent wetland. Abundance data may also be summarized by watershed, for example: 33% of the segments in the Frog Canyon watershed support wetlands.

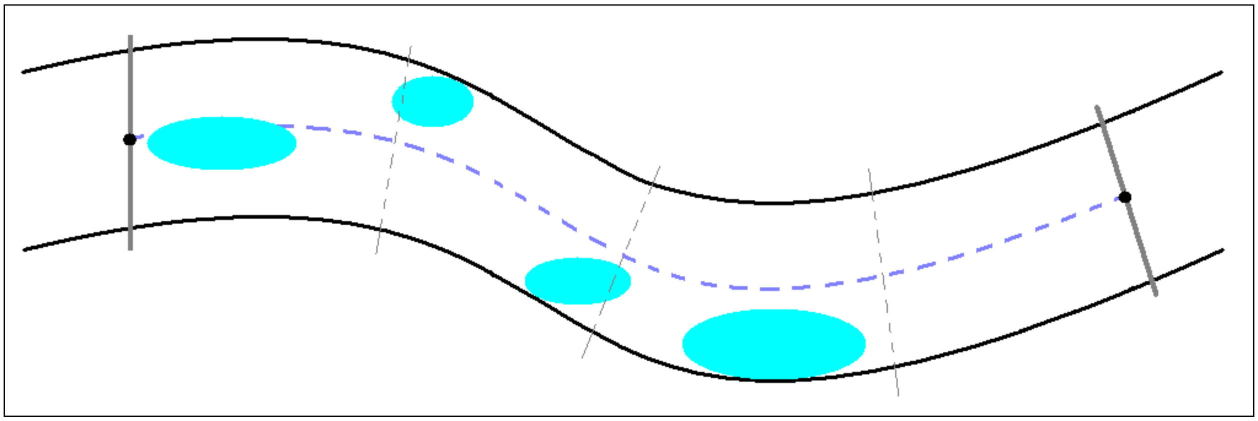

Figure 2.3. Wetlands (blue) observed within 25-meter segments (dashed gray lines) within one 100-meter reach (solid gray lines).Percent frequency of wetlands in this 100-meter reach (between solid gray bars) is 75%; however wetland percent frequency data will be summarized for entire streams and for the entire monument (for the 25-meter segments), not by 100-meter reaches.

Observers will note which hydrologic and vegetation wetland indicators are present, and note the Cowardin wetland type (SOP 7).

Wetland percent frequency data will be analyzed as a univariate dataset for trends (see section 2.6).

2.2.2.2 Riparian Vegetation Community Structure and Channel Morphology Characteristics (*Protocol Objectives 2 and 3*): Objective: Determine trends in vegetation communities (foliar cover for several general guilds, foliar cover of specific tree and shrub species, guild richness) of riparian areas at Pinnacles NM.

The vegetation community change metric will show changes in the density of the riparian canopy over the stream channels at Pinnacles NM. Declines in density or changes in vegetation composition may indicate a degradation of plant and wildlife habitat due to declining water tables, changing temperature or climate regimes, or flood and scour regimes.
Quantitative riparian vegetation community and channel morphology metrics are derived from data collected along transects oriented perpendicular to the channel center between bankfull banks. The bankfull width and the associated transect length will vary by stream and position in the watershed: stream bankfull width ranges from approximately 0.5–9 m at Pinnacles NM. Field observers will record information about riparian vegetation and substrate at 20 to 30 points distributed on the transect across the channel (*i.e.*, an adequate number of points to characterize the foliar cover and substrate characteristics within 3% or 5% percent-cover increments), and also record the bankfull width.

At each point on the transect observers will note all "hits" and record whether the pointing device encountered the following guilds: **grass**, **sedge**, **rush**, **forb**, **shrub**, **tree**, **algal mat**, **surface water**, and/or **rocky substrate**. These data will be averaged for the transect. Data will be analyzed by guild (*e.g.*, by grass cover) for each transect, as total vegetation cover, and as a metric reflecting vegetation complexity (*i.e.*, vegetation cover and number of vegetation guilds observed). Vegetation community structure data described above will be reported in End of Year Reports and also analyzed as several univariate datasets (guild cover, total cover, vegetation complexity metric) for trends.

At each point on the transect observers will also note the size of the substrate encountered in the channel, as measured with a gravelometer (see SOP 5). The gravelometer allows observers to place rocky substrate into one of 15 size classes. These data will be averaged for the transect. Substrate size data will be reported in End of Year Reports and analyzed as a univariate dataset for trends over time.

Finally, at each transect observers will record bankfull width. These data will be reported in End of Year Reports as current status, and analyzed as a univariate dataset for trends over time.

2.2.2.3 Additional Observations to Qualitatively Characterize Channel Reaches: No simple univariate quantitative metric, or even small sets of metrics, can characterize wetland and/or riparian habitat well. Although some restored wetlands are evaluated with intensive quantitative monitoring techniques (e.g., those tracking vegetation diversity, bird abundance), these are generally associated with specific restoration goals for highly degraded systems. This model is not applicable for evaluating the changing condition of relatively-unaltered sites across a park landscape.

The best available techniques, at present, for evaluating wetland condition at a landscape scale are based on rapid-assessment protocols, such as CRAM (Collins *et al.* 2008) and those developed by the California Native Plant Society (CNPS 2007). This protocol adopts some rapid assessment metrics from CRAM - those metrics that are most sensitive to change over time in the riparian and wetland habitat at Pinnacles NM. Other observations that can help managers qualitatively understand wetland and riparian habitat character are vegetation community, dominant vegetation and its estimated cover, channel type (*e.g.*, Rosgen 1996), presence of anthropogenic habitat stressors, and presence of non-native plant and animal species.

Ancillary data to be collected are:

Vegetation Community: the name of the vegetation community of the reach identified by Kittel *et al.* 2009. These data will be noted for each 100-meter reach.

Plant layers and dominant plants: for riparian plants - defined, as adopted from CRAM, as those plants that directly influence the stream channel (see SOP 5) - field staff will record the names and estimated absolute cover of all plants that comprise 5% or more of the absolute cover for each 100-meter reach. These plants will be tallied to estimate the absolute cover of each layer. There are a total of four possible layers (see botany datasheet in section 2.2.3). The number of layers with greater than 5% absolute cover will be used to assess the CRAM-derived vertical biotic structure metric for the reach. The tallest layer comprising greater than 10% absolute cover will be used to determine the vegetation community of the site. These data will be noted for each 100-meter reach.

Weed and Wildlife Watch Species: Field observers will note the presence of any of a small set of species that either network or monument biologists need more information about for active management (for species list see SOP 8). These include high-priority noxious invasive plant species and rare and non-native invasive animal species. The list of target plant species will be obtained each year before fieldwork from the network biologist implementing the Early Detection Monitoring Protocol for noxious plants and the monument botanist. The list of target wildlife species will be obtained from monument and network staff, also each year before the field season. As the purpose of these observations is management, not monitoring, the species list may fluctuate between years. Weed and Wildlife Watch lists should be limited to no more than 20 species per list. Data will be collected and reported for each 100-meter reach.

UTM Coordinates and Elevation: Observers will note the location of the downstream end of each reach with the GPS unit (easting, northing, and elevation). These data will be noted for the downstream beginning point for each reach.

Rosgen Channel Type: The Rosgen classification (Rosgen 1996) describes channel type by sinuosity, gradient, entrenchment, and substrate size. The classification is a commonly-used and useful structure for grouping channels with similar conformation. These data will be noted for each 100-meter reach.

Number of “Bankfull” Channels: observers will record the number of channels that will carry surface water during "bankfull" events, as observed at the downstream end of the reach. Some reaches at Pinnacles have two channels separated by vegetated or non-vegetated islands that rise above the bankfull elevation. For these streams, observers will record the "bankfull" width of each channel, and the total width from bankfull to bankfull elevation on the outside banks of the channels (see Figure 2.4). These data will be noted for the downstream beginning point for each reach.

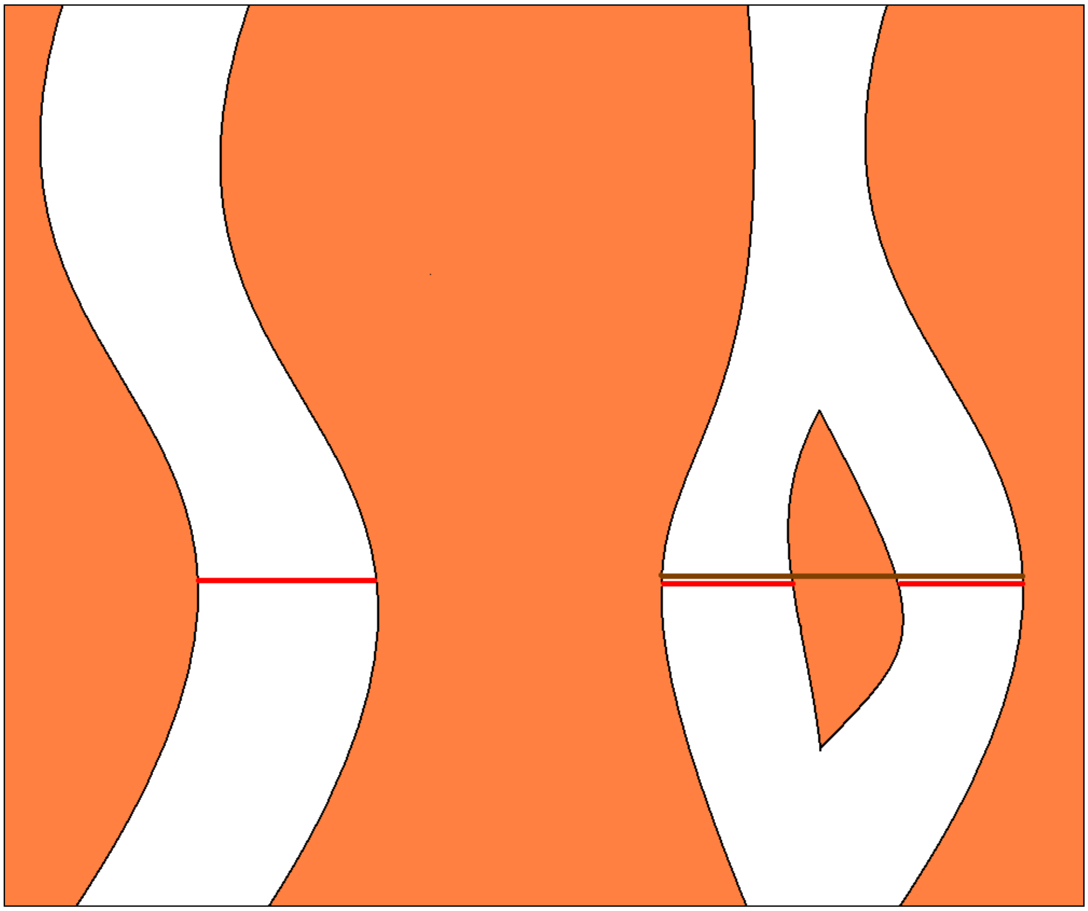

Figure 2.4. Diagram of bankfull channels. Reach depicted in left-hand drawing has one bankfull channel (white channel between black bankfull banks with orange upland); Reach depicted in right-hand drawing has two bankfull channels separated by upland mid-channel bar. Observers will measure bankfull width (red bar) and total channel width for reaches with two bankfull channels (brown bar). Bankfull width(s) will be measured at the downstream "reachpoint" of each reach and at each transect.

No or Limited Data Collected Due to Hazardous Conditions: Some reaches and transects at Pinnacles are overly unsafe for field staff to conduct work in (see SOP 2). Because staff will of necessity not collect data for these transects/reaches - most often due to dense or impenetrable vegetation - this protocol will underestimate foliar cover in riparian areas in the monument. However, based on pilot data collection and reconnaissance, these reaches and transects are estimated to represent less than one percent of all the potential reaches/transects and should not be a source of relevant bias at the landscape scale. Observers will merely skip over these sites and will not attempt to collect additional data elsewhere (for transects) to compensate. For each reach and transect for which observers cannot collect data due to saftety concerns, observers will note the reach location on the data sheet and identify the reason that the reach is too hazardous for data collection.

CRAM-derived Metrics: this protocol has adopted six rapid assessment metrics from CRAM version 5.02 (Collins *et al.* 2008). These include assessments of:

- Buffer Condition: what is the condition of the lands immediately adjacent to the reach?
- Channel Stability: what indications are present that the channel is aggrading, degrading, or in equilibrium condition, and how rapid does change appear to be occurring?
- Structural Patch Richness: how many different types of potential animal habitat does the reach and its adjacent floodprone area provide?
- Topographic Complexity: how complex is the cross-sectional profile of the channel?
- Horizontal Interspersion and Zonation: how complex is the interspersion of habitat patches in the reach?
- Vertical Biotic Complexity: how many plant layers are present and how much do they overlap?

These metrics above and the criteria for rapid assessments are described in greater detail in SOP 5. Assessments will be conducted for each 100-meter reach.

2.3 Data Collection Frequency and Replication

Data collected by this protocol will reflect broad changes in ecological processes - particularly habitat alteration due to changing water availability and vegetation community alteration due to invasions of non-native species (such as feral pigs). Each of these metrics, by itself, is not very sensitive to small changes, and each piece of information recorded at a specific location will tell observers very little about the condition of that site. The intention of this protocol is to provide a suite of general indications of ecosystem condition to allow future managers to evaluate change.

Because these metrics are not sensitive to small changes, the protocol should not be repeated more frequently than once every three years (Collins *et al.* 2008, Bunte and Abt 2001). Repeating the protocol every third year will allow network ecologists and monument managers to discern long-term trends against the background noise of interannual variation in vegetation cover and channel substrate size.

This design is not intended to require replication at other sites, as it does not seek to establish a strong relationship between a forcing agent and an ecological effect. Rather this protocol seeks to observe and track changes within a specified area. This can be accomplished without replicated data-collection in control - or "non-affected" - areas. In fact, it is not possible to find "non-affected" reference areas, as all areas within the monument's ecoregion are affected by both climate change and potential non-native species invasion.

Comparison with "pristine" reference sites is often recommended for analysis of wetland condition data (Collins *et al.* 2008, Brinson *et al.* 1995). This comparison is usually intended to establish quantitative or semi-quantitative thresholds in order to trigger management action - either restoration or mitigation. However, finding analogue reference sites to serve as ideal models for the monument's wetlands is not feasible, as its core lands have been under NPS protection for more than a century - generally free from mining and agriculture. Although these lands may be experiencing ongoing ecological change as a result of removal of Native Californian land management practices over a century ago, they are potentially the most ecologically-intact systems in the otherwise highly agricultural region. The newly-acquired lower floodplain lands at the monument have been subject to much more anthropogenic alteration - however, there are likely no areas in the Gabilan Mountains that would provide an analogue less altered by 20th-century agricultural practices than the original monument lands.

2.4 Timing of Fieldwork

Field work will be conducted once riparian shrub and tree species have reached full leaf-out but before summer heat causes drought-deciduous species to drop foliage. In order to meet these objectives the protocol should be implemented beginning in early- to mid-May and ending before mid-July.

Identification of wetlands using hydrology and vegetation indicators does not depend on observing sites during the wet season (*i.e.*, late fall through late spring). Rather, these indicators are visible year-round and are often more easily observed during the dry season.

2.5 Location of Data Collection Sites

A map of the monument's stream channels with catchments of 3 square kilometers or greater was created using GIS software ArcGIS 9.2 (ESRI 2008) and Hydro Tools (CRWR 2009) from a 30-meter Digital Elevation Model of the monument and surrounding lands (SOP 6). The coordinates of the upstream end of each stream - marked as either where the stream leaves the monument or at the point where the stream's catchment is less than 3 square kilometers - were generated by ArcGIS. Coordinates for major stream confluence points were also identified in GIS. All GIS-generated coordinates will be downloaded to a Trimble Geo XH GPS unit for use in the field. These will be updated as new Digital Elevation Models reflecting landscape changes become available. However, true confluence points to be used for determining the ends of stream reaches will be determined in the field each year (see section 3.2).

Within the channels with 3 square kilometer catchment size or greater, observers will locate the 100-meter stretches in the field (as described in Chapter 3). One-third of these reaches will be sampled for quantitative data reflecting substrate size and canopy cover. Selection of the location for the transect within the reach is conducted in the field. This design ensures random placement of transects and also interspersion of transects along the entire channel.

This design creates a framework of approximately 466 reaches for semi-quantitative rapid-assessment data collection and 155 sample units for more intensive quantitative data collection. The exact number of 100-meter long reaches and sample reaches may change slightly each year due to changes in channel length.

2.6 Level of Change that can be Detected for the Amount and Type of Data Collection

2.6.1 Protocol Objective 1: Determine trends in the abundance of wetlands associated with stream channels at Pinnacles National Monument

Protocol Objective 1 will be addressed by comparing the percent frequency of wetlands observed in all twenty-five-meter stream segments within the data collection frame between observation years. After each year of field data collection, the Principal Investigator / Project Coordinator will determine the overall percent frequency of wetlands in all the stream channels at Pinnacles NM (*i.e.,* the number of segments occupied by wetlands divided by the total number of segments observed) and compare with previous years (see section 4.4). The Principal Investigator / Project Coordinator will also evaluate changes in the percent frequency of wetlands by stream.

The network conducted pilot data collection on a limited number of the stream reaches in the monument in summer 2009 - for approximately 6.9% of the entire stream network within the data collection area. Observers collected data in four of the monument's 19 streams: Middle Chalone, North Wilderness, Frog, and Regan (see Appendix A). Within those reaches 37% of the 25-meter segments supported wetlands. However, this pilot study likely does not estimate the true overall abundance of wetlands in the monument very well, as the data were collected from such a small portion of the stream network. The first full year of data collection - from throughout the monument - will determine a baseline percent frequency of wetlands in 25-meter segments. Changes in the percent frequency of wetlands in the 25-meter segments will be detected in future sampling years.

2.6.2 Protocol Objective 2: Determine trends in vegetation communities (foliar cover by guild, foliar cover of trees and shrubs, guild richness) of riparian areas at Pinnacles NM

Protocol Objective 2 will be addressed by evaluating changes in foliar cover by guild and of trees and shrubs in cross-channel transects. In addition, Protocol Objective 2 will be met by evaluating the change in average number of guilds encountered per point on the cross-channel transects. Guilds included in the analysis are tree/shrub, forb, grass, sedge, rush, litter. All tree and shrub species encountered on the transect are identified to species. The average number of guilds present at points on the transect (guild richness) will provide a surrogate for structural complexity of the riparian habitat.

In 2009 the network collected pilot data at ten transects within four streams in the monument (Appendix A). For this pilot study observers collected data for the following guilds: trees/shrubs, graminoid plants, herbaceous plants, algal mats, and litter. Because these data were collected from so small a proportion of the monument stream system, they are inadequate to characterize the foliar cover or to provide a good estimate of the variability of foliar cover at Pinnacles NM. Also, variation between transects was high (Appendix A), because observers sought to collect pilot data from a diverse set of channels within the monument. Finally, because these data will be analyzed for change detection using statistical techniques for *permanent* sample units, any estimation of the power of this design to detect change would require assumptions about how tightly correlated the data will be between years. Because there is no knowledge to feed these assumptions, this protocol does not attempt to estimate the power of the design to detect change. Rather, the power of the design will be calculated after the first two implementation years (*i.e.,* rotations) as a post-hoc power analysis.

2.6.3 Protocol Objective 3: Determine trends in stream channel width and substrate size at Pinnacles NM

Protocol Objective 3 will be met by evaluating changes in bankfull widths of the permanent transects and evaluating changes in the average substrate size encountered in the channel. As with the guild cover data, an estimate of the power of the design to detect change cannot be calculated without assumptions. The power of the design to detect change will be calculated after the first two years of protocol implementation (i.e., after the first two full data-collection years).

2.6.4 Ancillary Data

Although this protocol is not designed specifically for change detection using the ancillary data collected (see section 2.2.2.3), post-collection exploration of these data may reveal significant habitat changes:

Vegetation Community: These data will be converted to a GIS shapefile, based on the UTM coordinates of each 100-meter reach. Maps showing these data will be presented in each End of Year Report for use by managers. Over longer time frames (*e.g.,* decades) the managers and network staff may wish to explore these data to show how riparian vegetation communities are changing in the monument over time.

Plant Layers and Dominant Plants: These data can be evaluated for change over time by analyzing changes in the park-wide absolute cover within each plant layer, changes in the number of dominant plants in each layer, and changes in the absolute cover of individual plants or guilds of interest (*e.g., Quercus* species).

Weed and Wildlife Watch Species: These data are collected for management purposes, and should be considered anecdotal as observers will not be systematically or consistently searching for these species.

UTM Coordinates and Elevation: These data are collected for the purpose of mapping data for presentation and use with GIS systems. Elevation data, however, may be employed as a cofactor when evaluating changes in riparian systems in the monument.

Rosgen Channel Type and Number of Bankfull Channels: These data will likely not change much over management-relevant timeframes. However, in the event of large changes in hydrology or land use, Rosgen channel type could change in portions of the monument, and the data collected for this protocol may provide a baseline against which large change can be evaluated. Also, as with elevation data, these may be used as a cofactor in data exploration.

No or Limited Data Collected due to Hazardous Conditions: The purpose of recording this information is not to show change over time, and there is likely substantial variation between observers regarding whether or not a reach or transect is safe enough for data collection. Other vegetation data gathered as part of this protocol are much better signals of change of vegetation density and surface water abundance.

CRAM-derived Metrics: These metrics are collected to quickly and repeatably (Clark *et al.* 2006) capture observers' judgment of the condition of the reach. These will be converted into a

GIS layer, based on stream reach UTM, to provide managers with overall single-visit assessments of the condition of stream reaches in the monument. These qualitative observational data can be used to interpret and help better understand changes in quantitative data.

Anthropogenic disturbance: These data are collected primarily for use by the monument to identify needed management action and locate high- and low-quality habitat. These data will be converted into a GIS layer, based on stream reach UTM coordinates. However, these data may be evaluated - particularly over longer time frames - for indication of changes in evident anthropogenic disturbance over time.

3 - Field Methods

3.1 Summary of Preparations for the Field Season and Equipment List

3.1.1 Preparations for the Field Season

San Francisco Bay Area Network staff are responsible for hiring or contracting personnel for each field season. Monument staff will assist with arranging for local accommodations and logistics, including informing field staff of local access restrictions and in-park communication procedures.

Fieldwork will be completed by two-person teams consisting of one technician with botanical and wetland identification skills and one technician with a basic knowledge of hydrogeomorphology. The botanical technician assigned to this project should have an ability to identify wetland and riparian plants of central California and an ability to recognize wetland hydrology indicators. The hydrogeomorphic technician should have an ability to ascertain bankfull position and field indicators of channel aggradation and degradation. Both technicians should have experience in implementing field data collection procedures in rough terrain and possess an ability to accurately record and transcribe data, conduct simple data analysis according to clearly-defined procedures (see SOP 5), and produce data reports. Once hired, these network and field staff should arrange logistics for field work and obtain needed training (see section 5.2) before beginning field work.

An important skill for field observers implementing this protocol is the ability to measure out distances on the ground accurately using pacing. Before beginning data collection, field observers should lay out an 100-meter tape in several stream channel types (*e.g.*, within the Sandy Creek mainstem, middle Chalone Creek, and lower Frog Creek) at Pinnacles and pace the distance while counting steps. Observers should calibrate pacing such that there is a 5% error or less in their ability to pace 100 m in the stream channel. This error margin is acceptable for the purpose of this protocol and also achievable in a wide range of stream types at Pinnacles NM, based on 2009 pilot testing.

Before each field work season, program personnel should contact the Pinnacles NM Chief of Resources Management to arrange local accommodations. Personnel should check with Pinnacles NM staff regarding permitting and compliance requirements. No formal National Environmental Policy Act compliance needs are anticipated. Of most concern may be permission to collect plant specimens that are not identifiable in the field, minor disturbance of riparian nesting birds due to travel in and alongside stream channels, and permission to lightly clip riparian plants in order to travel safely in stream corridors. Permitting is expected to consist of completion of an application for conducting investigations within the monument, and commitment to completing an Investigator's Annual Report - a two-page form - at the end of each season. Monument staff should make one monument radio available per field team. Vouchers will be collected for immediate identification purposes only, not for inclusion in floristic collections, unless the Pinnacles NM Chief specifies a need for collection of particular species.

Personnel should have personal protective equipment for work in the monument's hot and arid summer landscape and brushy stream corridors. This includes hats, sunglasses, sun screen, water bottles, boots, protective clothing, and specialized soap (*e.g.*, Tecnu) to help prevent Poison Oak dermatitis (see SOP 2 for a full Job Hazard Analysis).

3.1.2 Equipment List

The two-person field team will have the following equipment:

- 1 field notebook, including:
    - Key to Pinnacles NM plant communities
    - List of wetland plant species
    - Criteria for scoring CRAM-derived metrics
    - Sheet for identifying Rosgen-stream types
    - 7.5-minute quadrangles of the monument
- 2 field clipboards with blank datasheets
- 1 100-meter tape
- 1 25-meter tape
- 5 chain pins - 3 of these flagged with "1" "2" and "3" - and leather carry pouch
- 1 point sampling device
- 1 field backpack capable of carrying point sampling device
- 1 gravelometer
- 1 densitometer
- 1 compass
- 1 multitool (*e.g.*, Leatherman)
- 1 calculator with random-number generator
- 1 rangefinder
- 1 digital camera
- 1 GPS unit: Trimble Geo XH and beacon or comparably accurate technology
- 1 hand lens
- 1 pair small clippers
- 1 monument radio for emergency communication
- Plastic bags for collection of unknown plant specimens
- Permanent marker to label bags
- Keys for plant species identification

See SOP 3 for more detailed descriptions of equipment.

3.2 Detailed Information on Data Collection (Including Sample Data Collection Forms)

All sites will be accessed from park roads and trails. Observers will travel within and alongside stream corridors on foot. All sites will be visited in the same order each data-collection year; the most efficient sequence will be determined and documented during the first full season of data collection.

Observers first navigate to one of the points marked as “confluence” on the base protocol map (see Figure 2.1, Chapter 2). In the field, observers locate the point at which the stream to be evaluated meets the receiving stream, at the bankfull elevation of the receiving stream (see Figure 3.1). Observers will place a chain pin at the channel center and stretch a 100-meter tape upstream along the stream to be evaluated. Observers will then pace back to the confluence along the 100-meter tape to create an initial estimate of the number of paces needed to travel 100 m in this stream type. Whenever observers are uncertain about their ability to pace accurately - for example, due to dense vegetation or large channel bed materials - they will measure, rather than pace, the reach.

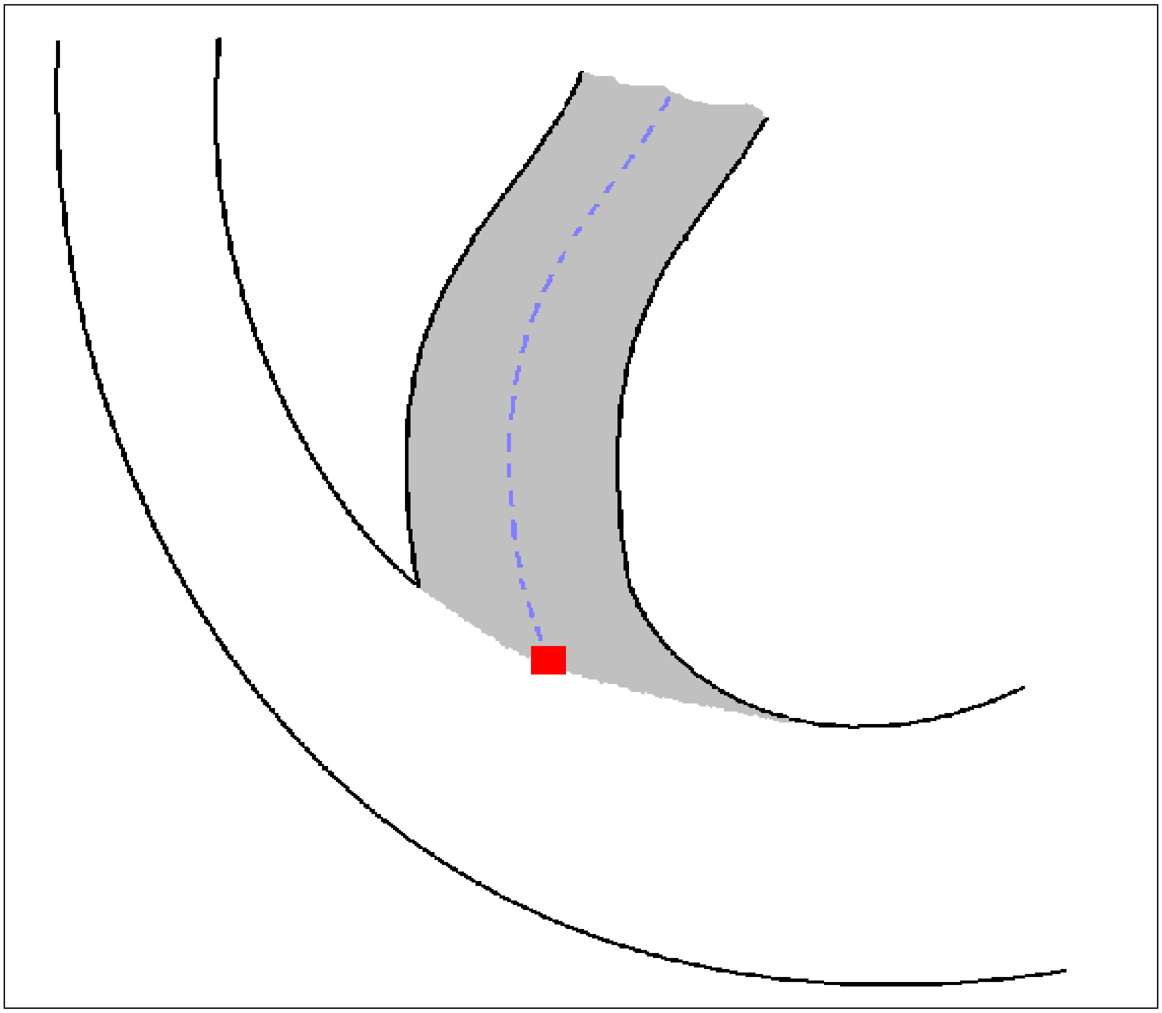

Figure 3.1. Placement of chain pin (red square) at lowest elevation of channel center (dashed blue line) of stream to be evaluated (gray) at bankfull elevation (black line) of receiving stream.

Data will primarily be collected in 100-meter reaches of the stream (Figure 3.2). For each reach observers will identify vegetation community type, dominant plant species in and contributing to the channel and their absolute cover, Rosgen stream type, and presence/absence and size class of wetlands (see SOP 5).

Observers will record the location of the downstream end of the reach at the channel center with a GPS unit, identify channel bankfull, and measure bankfull width with either a tape measure or range-finder - depending on channel width. In some reaches at Pinnacles NM the stream splits into two channels which each receive bankfull flow (*i.e.*, flow in a 1.5 to 2 year flood). In these cases observers will record the bankfull width of each channel at downstream end of the reach.

For each 100-meter reach observers will also evaluate several stream characteristics according to methods described in the California Rapid Assessment Method for Wetlands (CRAM) (see SOP 5).

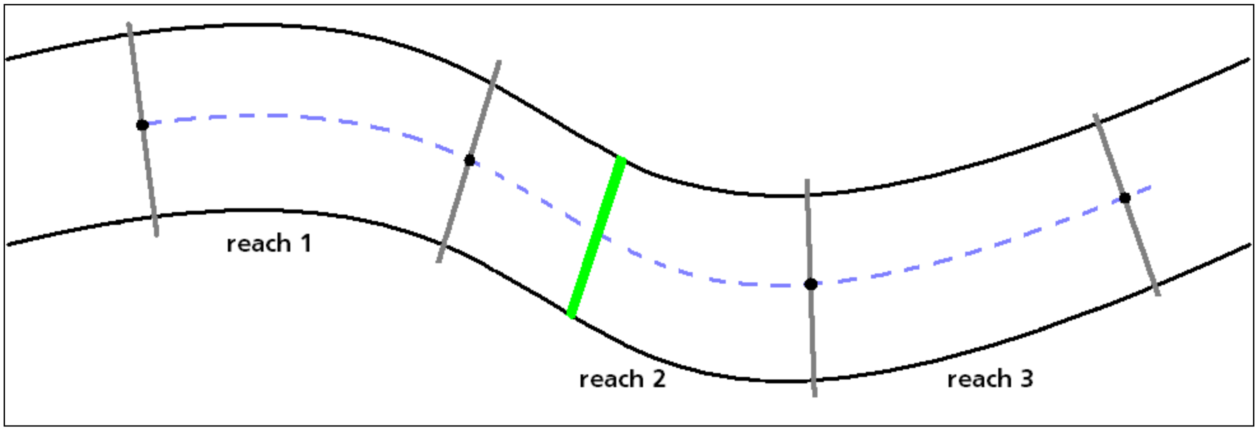

Figure 3.2. Data will be collected within the bankfull banks (black line) of each 100-meter reach. Reach ends (gray lines) are oriented perpendicular to the channel center (blue dashed line); one out of every three 100-meter reaches will include a transect (green line) running perpendicular to the channel center; black circles indicate the downstream beginning point for each reach.

One out of every three reaches will include a transect for evaluating riparian vegetation cover and channel substrate. During the first year the protocol is implemented, at the downstream end (beginning point) of each stream observers will choose a random number between 1 and 3; this will indicate in which reach observers will place the first transect. Observers will then choose a random number between 0 and 99; this will indicate at which point on the 100-meter reach tape the transect will be placed. As observers move up the stream each new transect will fall 300 m from the previous one. The location where this transect crosses the center of the channel will be identified using a GPS unit. In future years observers will navigate back to these transects based on GPS-established coordinates.

For reaches that do not include transects, observers will pace 100-meters, rather than laying out a 100-meter tape. This will allow field observers to traverse these reaches only once while traveling upstream, rather than having to walk every reach 2-3 times to collect data, lay tape, and retrieve tape.

To begin reading a non-transected reach, the Hydrogeomorphology Technician will record the location of the downstream end ("reachpoint") of the reach using the GPS unit. The technician will determine the bankfull elevation of the channel on its banks and measure the bankfull channel width using the 25-meter tape measure or the rangefinder. The technician will then pick up the GPS unit (once it has recorded the location of the reachpoint) and start pacing upstream. When the technician passes the 25 meter point along the reach he/she will place a chain pin marked "1." The technician will continue upstream, placing a marked pin at the 50 meter and 75 meter points and at the end (100-meter point) of the reach. While pacing the technician will carefully observe the channel in order to be able to evaluate the CRAM-derived metrics for the reach (see SOP 5). When the technician arrives at the end of the reach he/she will place the last chain pin and evaluate the reach with respect to the CRAM-derived metrics (see Figures 3.3 and 3.4).

The Botany Technician will follow up the channel, retrieving the chain pins, and evaluating and recording the absolute dominant vegetation in layers, as well as noting the presence and size class of wetlands observed in each 25-meter segment (see SOP 5). The technician will estimate the absolute cover of each of four vegetation layers: plants greater than 3 m tall; plants between 1.5–3 m tall; plants 0.75–1.5 m tall; and plants less than 0.75 m tall. The technician may use the striped 1-m stadia rod attached to the point sampling device to help estimate vegetation height. These plant layers are derived from CRAM, which adopted them for the purpose of characterizing wetland vegetation after extensive field testing in California wetland and riparian habitats. After estimating absolute abundance of each layer, the technician will note dominant plant species in each layer. (see SOP 5 and Figures 3.5 and 3.6).

Each reach that contains a transect will be measured, not paced, along the channel center with the 100-m tape. Observers will recalibrate their pacing at each of these measured reaches to ensure that the pacing error is within 5% of the measured distance. Both field observers will participate in reading the transect: first observers will identify bankfull at the transect location and string the 50-m tape across the channel between bankfull elevations on the banks. The observers will record information about the vegetation canopy and substrate along the transect at 20 to 30 individual points (allowing for estimation of cover in 3% to 5% increments - for example for a transect with 20 points, the cover estimate will be a multiple of 5, *e.g.*, 65%). For transects less than 2 m long there will be fewer than 20 points, as it is impractical to record data at closer than 5 cm intervals and fewer points are adequate to characterize the diversity across the narrow channel.

Table 3.1. Distance between sample points based on bankfull width of channel.

Channel Width at Bankfull	Distance Between Points on Transect Tape
0.5–1.0 m	0.05 m
1.1–1.5 m	0.075 m
1.6–3.0 m	0.1 m
3.1–4.5 m	0.15 m
4.5–6.0 m	0.2 m
6.1–7.5 m	0.25 m
7.6–9.0 m	0.3 m

Presence of tree or shrub foliar canopy overhead will be evaluated at each point using a GRS densitometer. Presence of vegetation at or near ground level and presence of litter and channel substrate will be evaluated using a point sampling tool. At each sample point the rocky or sandy channel substrate encountered will be measured with a gravelometer (Bunte and Abt 2001). See SOP 3 for descriptions and photos of equipment.

At each point along the transect observers will note:

- Presence and species of trees/shrubs encountered (i.e., “hit” with sampling device)
- Presence of forbs encountered
- Presence of grass encountered
- Presence of sedge or rush encountered
- Presence of litter, algal mat, or surface water
- Presence of bedrock (channel bed rocks with a short-axis diameter of 363 mm or more [Bunte and Abt 2001])
- Presence and size of mobile channel substrate (channel bed rocks with a short-axis diameter of 362 mm or less)

Data for each reach will be recorded on two separate datasheets (Figures 3.3 – 3.5) to allow for more efficient data collection by the Botany and Hydrogeomorphology Technicians. The Hydrogeomorphology Technician will record data on the "reach condition" datasheets. These are of two types: those for reaches with transects (Figure 3.3) and those for reaches without transects (Figure 3.4). The Botany Technician will record reach and segment data on the "botany" datasheet (Figure 3.5) and also keep a record of plants observed on the "plant" datasheet (Figure 3.6; see SOP 5 for more detail regarding data collection).

PINN Wetland and Riparian Monitoring Datasheet: Reach Condition

Date/Time:	Observers:
Creek:	Reachpoint number (downstream):
Reachpoint UTMN:	Reachpoint UTME:
Number of bankfull channels at reachpoint: 1 2	Reachpoint elevation:
Channel width 1 at reachpoint:	Rosgen type:
Channel width 2 at reachpoint: Total width:	
No or Limited data collection due to hazard: Poison Oak Other Vegetation Other:	

CRAM-derived metrics	
Buffer Conditon	A B C D
Channel Stability	A B C D
Equilibrium Conditions	1 2 3 4 5 6 7 8
Active Degradation	1 2 3 4 5 6 7
Active Aggradation	1 2 3 4 5
Structural Patch Richness	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Topographic Complexity	A B C D
Horizontal Interspersion and Zonation	A B C D
Vertical Biotic Structure	A B C D
	Other:

Transect Data **Bankfull width at transect:**

Photo number:

No data collection: Poison Oak Other Vegetation Other:

Position (cm)	Tree/ Shrub	Forb	Grass	Sedge/Rush	Litter/ Algal Mat/ Water	Rock	Position (cm)	Tree/ Shrub	Forb	Grass	Sedge/Rush	Litter/ Algal Mat/ Water	Rock
1							35						
2							36						
3							37						
4							38						
5							39						
6							40						
7							41						
8							42						
9							43						
10							44						
11							45						
12							46						
13							47						
14							48						
15							49						
16							50						
17							51						
18							52						
19							53						
20							54						
21							55						
22							56						
23							57						
24							58						
25							59						
26							60						
27							61						
28							62						
29							63						
30							64						
31							65						
32							66						
33							67						
34							68						

Figure 3.3. Datasheet 1: Reach condition datasheets for reaches with transects.

PINN Wetland and Riparian Monitoring Datasheet: Reach Condition

Date/Time:	Observers:
Creek:	Reachpoint number (downstream):
Reachpoint UTMN:	Reachpoint UTME:
Number of "bankfull" channels at reachpoint: 1 2	Reachpoint elevation:
Channel width 1 at reachpoint:	Rosgen type:
Channel width 2 at reachpoint: Total width:	
No or Limited data collection due to hazard: Poison Oak Other Vegetation Other:	
CRAM-derived metrics	
Buffer Conditon	A B C D
Channel Stability	A B C D
Equilibrium Conditions	1 2 3 4 5 6 7 8
Active Degradation	1 2 3 4 5 6 7
Active Aggradation	1 2 3 4 5
Structural Patch Richness	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Topographic Complexity	A B C D
Horizontal Interspersion and Zonation	A B C D
Vertical Biotic Structure	A B C D
	Other:
Date/Time:	Observers:
Creek:	Reachpoint number (downstream):
Reachpoint UTMN:	Reachpoint UTME:
Number of "bankfull" channels at reachpoint: 1 2	Reachpoint elevation:
Channel width 1 at reachpoint:	Rosgen type:
Channel width 2 at reachpoint: Total width:	
No or Limited data collection due to hazard: Poison Oak Other Vegetation Other:	
CRAM-derived metrics	
Buffer Conditon	A B C D
Channel Stability	A B C D
Equilibrium Conditions	1 2 3 4 5 6 7 8
Active Degradation	1 2 3 4 5 6 7
Active Aggradation	1 2 3 4 5
Structural Patch Richness	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Topographic Complexity	A B C D
Horizontal Interspersion and Zonation	A B C D
Vertical Biotic Structure	A B C D
	Other:
Date/Time:	Observers:
Creek:	Reachpoint number (downstream):
Reachpoint UTMN:	Reachpoint UTME:
Number of "bankfull" channels at reachpoint: 1 2	Reachpoint elevation:
Channel width 1 at reachpoint:	Rosgen type:
Channel width 2 at reachpoint: Total width:	
No or Limited data collection due to hazard: Poison Oak Other Vegetation Other:	
CRAM-derived metrics	
Buffer Conditon	A B C D
Channel Stability	A B C D
Equilibrium Conditions	1 2 3 4 5 6 7 8
Active Degradation	1 2 3 4 5 6 7
Active Aggradation	1 2 3 4 5
Structural Patch Richness	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Topographic Complexity	A B C D
Horizontal Interspersion and Zonation	A B C D
Vertical Biotic Structure	A B C D
	Other:

Figure 3.4. Datasheet 2: Reach condition datasheets for reaches without transects

PINN Wetland and Riparian Monitoring Datasheet: Botany

Date/Time:	Observers:
Creek:	"Reach point" number (downstream):
Vegetation Community of Reach:	

Wetlands Present in Reach	*Type*	*Hydro Indicators*	*Veg Indicators*	*Size Class*
0 to 25 meters of reach				
25 to 50 meters of reach				
50 to 75 meters of reach				
75 to 100 meters of reach				

	Estimated Absolute Cover of Layer	Name	*Estimated Absolute Cover*
Very Tall Dominant Plants (>3m)			
Tall Dominant Plants (1.5-3m)			
Medium Dominant Plants (0.75-1.5m)			
Short Dominant Plants (<0.75m)			

Wildlife Watch Species		*Number*	Early Detection Plant Species		*Estimated Absolute Cover*
Gambusia affinis	Mosquitofish		*Acroptilon repens*	Russian knapweed	
Clemmys marmorata	Western pond turtle		*Ailanthus altissima*	Tree-of-heaven	
Elanus leucurus	White-tailed kite		*Arundo donax*	Giant reed	
Lepomis spp.	Green sunfish *or* bluegill		*Centaurea melitensis*	Napa thistle, tocalote	
Rana catesbeiana	Bullfrog		*Centaurea solstitialis*	Star thistle	
Rana draytonii	CA red-legged frog		*Chenopodium ambrosioides*	Mexican tea	
Sus scrofa	Wild pig		*Conium maculatum*	Poison hemlock	
various	Crayfish		*Dittrichia graveolens*	Stinkweed	
various	Owl		*Iris pseudacorus*	Yellow flag	
Other bird of prey (describe):			*Marrubium vulgare*	Horehound	
			Melilotus alba	White sweetclover	
			Mentha spicata	Peppermint	
			Nicotiana glauca	Tree tobacco	
			Rubus discolor	Himalayan blackberry	
			Tamarix ramosissima	Tamarisk	
			Verbascum thapsus	Wooly mullein	

Figure 3.5. Datasheet 3: Botany datasheet.

Plants

Date: **Observers:**

Plant Code	Full Plant Name	Plant Code	Full Plant Name

Figure 3.6. Datasheet 4: Plant species datasheet

3.3 Method of Accessing Data Collection Sites

All sites will be accessed on foot from monument trailheads and parking areas. Observers will travel in stream channels, or - for the short reaches for which this is infeasible due to dense or dangerous terrain or vegetation or deep water - immediately alongside the channel.

3.4 Procedures for Selecting and Finding Data Collection Sites

Data collection locations for the 100-meter reaches will be determined in the field each season that the protocol is implemented, as described in section 3.2. These will not be permanently marked, but rather re-positioned each season. These do not represent a "sample" of stream reaches within the area surveyed, as all reaches with a catchment of greater than three square kilometers are included.

Locations for channel cross-section transects, however, will be placed in a permanent location for re-finding each year, in order to increase the ability of the protocol to detect change in the riparian canopy, channel substrate, and channel width. These transects will be placed during the first year of full data collection, and the point at which the transect intersects the center of the stream channel will be recorded with a high-accuracy GPS unit (Trimble Geo XH and beacon, or unit with +/-1 m accuracy or better). In future years observers will use GPS technology to navigate back to the same location. Conditions within several meters of transects are adequately similar that true changes over time in the canopy or substrate will not be masked by the imprecision of relocating transects via GPS.

3.5 Post-Collection Processing of Data

Field observers will enter data into the project database weekly and send datasets to the Principal Investigator / Project Coordinator for review at the end of each week during the field season. The Biology Technician is responsible for entry of data on the Botany datasheet; the Hydrogeomorphology Technician is responsible for data on the Reach Condition datasheet. Both technicians are responsible for reviewing 5% of the entered data weekly to evaluate the error rate. The Principal Investigator / Project Coordinator will also review at least 5% of the entered data each week during the field season to look for evident problems with data collection and data entry. The Principal Investigator / Project Coordinator will send an informal list of Weed Watch and Wildlife Watch species observed, and the locations observed, to monument managers and the network Early Detection Coordinator weekly during the data-collection season. This will allow managers to effect a prompt response if warranted.

The Botany Technician will consult with monument staff for identification of unknown plant specimens as soon as possible after data collection, update field datasheets promptly with plant identities, and preserve or dispose of plant materials according to monument staff instructions.

The Hydrogeomorphology Technician will upload geographic coordinates from field equipment and photodata from the field camera, ensure that these data are coded correctly with the reaches and transects that they represent, and burn these data onto data CDs or save them on other stable media weekly to avoid data loss or mislabeling.

3.6 Procedures to be Followed at the End of Each Field Season

At the end of each field season the technicians will ensure that all original datasheets are returned to the Principal Investigator / Project Coordinator for data validation and archiving. The technicians will evaluate the condition of all field equipment, remove batteries and clean equipment, make recommendations to monument and/or network staff regarding equipment repair or replacement, and return all equipment to monument/and network staff. The Principal Investigator / Project Coordinator will store network equipment and arrange for repairs or for equipment replacement. All equipment will be labeled and/or stored in labeled boxes with contents identified so that the equipment is available for the next data-collection season.

The Principal Investigator / Project Coordinator will compare at least 5% of the entered data with the original datasheets to ensure accurate data transcription. The Principal Investigator / Project Coordinator will compile all electronic data (database, site coordinates, and photo documentation) into one file structure and work with the Network Data Manager for long-term data storage. The Principal Investigator / Project Coordinator will also work with monument staff and archivist of record for the monument to appropriately archive original data collection sheets and electronic media (*e.g.*, photodata).

The Principal Investigator / Project Coordinator will also summarize the year's data (see section 4.5), evaluate whether or not there has been any significant change since the previous data-collection year, and report the results in an End of Year Report. The End of Year Report will be reviewed and edited by the Network Program Manager, the Network Data Manager, and monument staff. The Principal Investigator / Project Coordinator will finalize the report based on comments (see section 4.8) and disseminate the final report to appropriate network and monument personnel.

This protocol will potentially undergo moderate revision after the first full data collection season, and a thorough effectiveness review after every third monitoring year. The Principal Investigator / Project Coordinator and network staff will carefully analyze these data sets for the following, at a minimum:

- Were the field technicians able to access all sites, collect data, and enter data within the estimated time frame?
- Were the field technicians able to confidently and accurately collect data for all of the metrics, or was there substantial opportunity for observer bias?
- Do the data collected represent the information that monument managers and network ecologists wish to portray with this monitoring effort?
- Are any metrics superfluous and able to be dropped to increase efficiency? Should any metrics be added, and can they be added while not increasing project expense?
- Can the datasheets, reference materials, and database be used efficiently, or do they need revision to reduce error and increase efficiency?
- Are there alternative analysis procedures that would better represent the data and show change over time?
- What is the change detection capability of the design, based on the first full dataset?

4 - Data Handling, Analysis, and Reporting

4.1 Overview of Data Processing and Storage Procedures

This section briefly describes the data management model and procedures for the wetland monitoring program at Pinnacles National Monument. SOP 4: Data Management and Quality Assurance describes in more detail how the wetland monitoring protocol meets data management objectives through data entry specifications, database design, quality assurance and control measures, metadata development, data maintenance, data storage and archiving, and data distribution.

During each monitoring season, data are entered by the field staff directly into the master Pinnacles NM wetland monitoring database. Data entry should occur as soon as possible following data collection in the field. The network Data Manager will ensure that field staff are properly trained in using Microsoft Access and in navigating the wetlands database prior to data entry. The database is provided in Microsoft Access XP format.

The database should be backed up regularly during the course of the monitoring season and data entry. CDs are a good option for back-ups. Databases can be also be regularly copied to an archive on the network, to a hard drive, or both. File names of back-up databases should include the date of the back-up, such as: PINN_Wetlands_v1_00_080109_BackUp.

At the end of each season, the field staff is responsible for proofing the data entry records in the database against field notes and paper datasheets completed during the surveys. When complete, the database is sent or provided to the network Data Manager for additional review and certification. The Data Manager works with the Principal Investigator / Project Coordinator and the field staff to complete any final edits or additions to the new monitoring dataset. Final steps include documentation in the database history log and an update to the database metadata record.

4.2 Quality Assurance and Quality Control Procedures

The success of the wetland monitoring protocol is dependent on the quality of the data it collects, manages, and disseminates. Analyses performed to detect ecological trends or patterns require data that are recorded properly and have acceptable precision, accuracy, and minimal bias. Poor-quality data can limit detection of subtle changes in ecosystem patterns and processes, can lead to incorrect interpretations and conclusions, and can greatly compromise the credibility of the program managing it.

Quality assurance (QA) can be defined as an integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the consumer. Quality control (QC) is a system of technical activities that measure the attributes and performance of a process, item, or service relative to defined standards (Palmer 2003). While QA procedures maintain quality throughout all stages of data development, QC procedures monitor or evaluate the resulting data products.

To ensure that the wetland monitoring protocol produces and maintains data of the highest possible quality, QA/QC procedures are implemented to identify and minimize errors at each project stage associated with the data life cycle. SOP 4: Data Management and Quality Assurance outlines specific QA/QC guidelines and procedures to be followed during data entry, data collection, data verification, and data validation.

4.3 Data Structure and Database Design

4.3.1 Database Design

Network staff have developed a relational Microsoft Access XP database for the riparian and wetland monitoring program at Pinnacles NM compliant with the Natural Resource Database Template Version 3.2, an application developed by the National Park Service's Natural Resource Inventory and Monitoring Program.

The data in the wetland database are simply organized around survey events of defined 100-meter reaches along select streams within Pinnacles NM. The primary wetland monitoring events table, tbl_Events, is linked to sub-tables storing data on wetlands found within the stream reach, the absolute cover of dominant plant species within the reach, vegetation data along a permanent transect within the stream reach, and the list of field staff present on the survey via an Event_ID Globally Unique Identifier.

The geographic coordinates of each 100-meter stream reach are entered into tbl_Events each time the stream reach is surveyed during the course of this monitoring protocol. Spatial data relating to permanent transects established within the 100-meter reaches is stored in tbl_Transect_Locations. Stream reaches and transects can be grouped by a common geographic placement, which, in this case, is the stream itself. Stream names stored in tbl_Sites are assigned a unique Site_ID value, which provides a link to tbl_Events and tbl_Transect_Locations, and thus a means to spatially aggregate the data.

4.3.2 Version Control Guidelines and Database History

Version control guidelines for the Pinnacles NM wetland monitoring database will follow those presented in the network's Data Management Plan (Press 2005). Prior to any major changes to the database design, a back-up copy of the database should be made. Once the database design changes are complete, the database should be assigned the next incremental version number. The final copy of the previous database version should be archived with the version closing date incorporated into the database title. Version numbers should increase incrementally by hundredths (*e.g.,* version 1_01, version 1_02, *etc.*) for minor changes. Major revisions should be designated with the next whole number (*e.g.,* version 2_0, 3_0, 4_0 …). Significant database re-design may require approval by the Project Coordinator, review by other data management staff, and revisions to this data management SOP. The database version number should be included in the file title of the database, for example, PINN_Wetlands_v1_00.

The Data Manager maintains an additional history log of the wetland monitoring database in a Microsoft Word document titled PINN_Wetland_Database_Log.

All design modifications to the database are tracked within the history log and are referenced to changes in database version numbers. Design modifications include changes to the table structure, user interface, or underlying macros and Visual Basic Code. Major changes to the data themselves are also noted in this document, such as when a new set of monitoring data is certified. It is especially important to note edits to the data that will result in changes to final data summaries previously published in End of Year Reports or other media. This will prove invaluable to data users attempting to understand differences in data between years.

4.3.4 Data Distribution

In order for the monitoring program to inform monument management and to share its information with other organizations and the general public, guidance documents, reports, and data must be easily discoverable and obtainable. The main mechanism for distribution of the monitoring documents and data will be the Internet. The monitoring protocol, accompanying SOPs, and all End of Year Reports will be made available for download at the network website: http://science.nature.nps.gov/im/units/sfan/

Although the wetland monitoring database will not be posted for public download, metadata records for the master database will be maintained at the NPS Data Store. The metadata records will direct interested parties to the network Data Manager for further inquiries.

In addition to the NPS Data Store, the NPS Inventory and Monitoring Program maintains an on-line natural resource bibliographic database known as NatureBib. NatureBib records will be created for all of the Pinnacles NM monitoring documents, including the protocol, End of Year Reports, and any resulting publications.

4.4 Recommendations for Routine Data Summaries, Statistical Analyses, and Trend Analysis

This section presents recommendations for formats for data that should be reported each sampling year (Table 4.1), geographic information that should be reported each sampling year (Table 4.2), and recommendations for presentation of trend analyses (Table 4.3).

Table 4.1. Status summaries: reported for each data collection year.

Data	Expected Summary	Example Summary Statement*
Abundance of wetlands	Reported for all 100-meter reaches throughout the monument and by stream	40% of 25-meter segments in Marion Canyon contain wetlands (no associated error; data collected via census of all 100-meter reaches within the monitored stream network)
Foliar cover of riparian vegetation by guild	Reported for all transects throughout the monument with precision specified, also reported by stream with precision specified	*Graminoid* species cover in Middle Chalone Creek 75% +/- 10% absolute
Foliar cover of riparian trees/shrubs by species	Reported for all transects throughout the monument with precision specified, also reported by stream with precision specified	*Quercus agrifolia* cover in Upper Chalone Creek channels 15% +/- 3% absolute
Channel bankfull width	Reported for all transects throughout the monument with precision specified, also reported by stream with precision specified	Bankfull channels in McCabe canyon 3.6 m wide +/- 0.2 m
Channel substrate size	Reported for all transects throughout the monument with precision specified, also reported by stream with precision specified	Average short-axis particle size for all channel beds in the monument 28.8 millimeters +/- 1.2
Cover of exposed bedrock in the channel	Reported for all transects throughout the monument with precision specified, also reported by stream with precision specified	North Wilderness Tributary with 5% exposed bedrock cover in channel, +/- 0.8% absolute
Cover of each plant layer	Reported for all 100-meter reaches throughout the monument and by stream	All stream channel reaches with an average of 5% cover of very tall plants (ranging between 0% and 75% cover)
Cover of plants of interest to managers	Reported for all transects throughout the monument with precision specified, also reported by stream with precision specified; may also be converted to GIS shapefile (by 100-meter reach) by absolute cover estimate for graphical presentation	Frog Canyon channel with 28% *Platanus racemosa* cover +/- 5% absolute

Table 4.2. Geographic Information Summaries: Reported for each data collection year.

Data	Expected Summary
Vegetation communities	Data converted to GIS shapefile and presented on maps in End of Year Report
Rosgen stream types	Data converted to GIS shapefile and presented on maps in End of Year Report
CRAM-derived metrics	Data converted to GIS shapefile and presented on maps in End of Year Report

Table 4.3. Analysis of trend data.

Data	Analysis between data-collection years (*e.g.,* between Year 1 and Year 4 of protocol implementation)	Multiple-year analysis
Abundance of wetlands	Direct comparison between years (census data, no sampling) for all reaches throughout the monument and by stream	Logistic regression analysis for binary dataset; to be undertaken after every third data-collection year (for frequency data – i.e., for all the 25-meter segments in the sample frame, how many of these contain wetlands?)
Foliar cover of riparian vegetation by guild	Paired t-tests for all transects and transects of each stream	Linear regression analysis for parametric dataset; to be undertaken after every third data-collection year
Foliar cover of riparian trees/shrubs by species	Paired t-tests for all transects and transects of each stream	Linear regression analysis for parametric dataset; to be undertaken after every third data-collection year
Number of riparian vegetation guilds	Paired t-tests for all transects and transects of each stream	Linear regression analysis for parametric dataset; to be undertaken after every third data-collection year
Channel bankfull width	Paired t-tests for all transects and transects of each stream	Linear regression analysis for parametric dataset; to be undertaken after every third data-collection year
Average channel substrate size	Paired t-tests for all transects and transects of each stream	Linear regression analysis for parametric dataset; to be undertaken after every third data-collection year
Cover of exposed bedrock in the channel	Paired t-tests for all transects and transects of each stream	Linear regression analysis for parametric dataset; to be undertaken after every third data-collection year
Cover of plants of interest to managers	Paired t-tests for all transects and transects of each stream	Linear regression analysis for parametric dataset; to be undertaken after every third data-collection year

*All estimates restricted to those stream reaches in the monument with watersheds of three square kilometers or greater.

Please see Appendix B for examples of linear regression and logistic regression analysis with simulated data.

4.5 Recommended Reporting Schedule

Data gathered by this monitoring program will be analyzed and summarized in an End of Year Report after each data-collection season - once every third calendar year. In addition, the Principal Investigator / Project Coordinator will send weekly informal updates to monument managers and to the network Early Detection Coordinator during the data collection season regarding Weed Watch and Wildlife Watch species observed. Long-term trends incorporating all data collected to-date will be reported after each third data collection year.

4.6 Recommended Report Format

Data gathered by this monitoring program has multiple potential audiences: these include monument managers, other natural lands managers, research collaborators, lawmakers, and the interested public. The primary audience for this data are monument managers: the program's End of Year Report will be addressed to this group to assist them with making and defending appropriate management decisions to protect monument resources. Please see Appendix A of this document for an example of a summary table of these data. This End of Year Report format will comply with NPS Inventory and Monitoring standards (current standards at http://www.nature.nps.gov/publications/nrpm/) and will include, at a minimum:

- Executive Summary (for managers)
- Background Rationale (for monitoring program)
- Monitoring Objectives
- Brief Synopsis of Monitoring Design
- Description of Metrics
- Summary of Results
- Quantitative data: current status
- Abundance of wetlands,
- Foliar cover of riparian vegetation by guild,
- Foliar cover of riparian trees/shrubs by species,
- Channel bankfull width
- Channel substrate size,
- Cover of exposed bedrock in the channel,
- Abundance of channels dominated by non-native grasses
- Cover of each plant layer
- Cover of plants of interest to managers (*e.g., Quercus* spp.)
- Geographic data: presented as shapefiles and paper maps
- Vegetation communities,
  Rosgen stream types,
- CRAM-derived metrics,
- Depth of surface water
- Quantitative data: change detection (for the second and subsequent data-collection years and beyond)

- Abundance of wetlands,
- Foliar cover of riparian vegetation by guild,
- Foliar cover of riparian trees and shrubs by species,
- Number of riparian vegetation guilds,
- Channel bankfull widths of transects,
- Average channel substrate size,
- Cover of exposed bedrock in the channel,
- Abundance of channels dominated by non-native grasses
- Cover of plants of interest to managers (*e.g.*, *Quercus* spp.)

- Interpretation of Results
- List of Reviewers
- Addendum: Assessment of the Monitoring Program (see section 4.8)
- Addendum: Management Implications (see section 4.8)

The Principal Investigator / Project Coordinator will summarize results for monument managers and network staff as a short presentation (*e.g.*, as a "brown bag" lunchtime presentation or as part of a resource management meeting).

In addition to the End of Year Report, the Principal Investigator / Project Coordinator will send weekly updates to monument managers and the network Early Detection Coordinator regarding Weed and Wildlife Watch species. These reports can be very informal, consisting of simple tables listing:

- Weed and Wildlife Watch Species Observed
- Weed and Wildlife Watch Species Abundance Estimate (in numbers of animals or absolute cover of plants)
- Stream Name
- Reach Number (indicating the distance, in 1/10 kilometer from the downstream monument boundary or stream confluence)
- UTM Easting coordinate of the reachpoint
- UTM Northing coordinate of the reachpoint

These weekly updates will be included in an appendix of the End of Year Report, along with a summary of the species observed throughout the data collection period.

Also, after the first full year of data collection, the Principal Investigator / Project Coordinator and network staff will complete a careful review of the project, including at a minimum the issues raised in section 3.6. This analysis will be included as an appendix to the first End of Year Report.

Communication about the status of parks' natural resources to interested individuals beyond the agency is essential to the NPS mission. Network staff will summarize the results of this monitoring program through documents intended for a various audiences such as monument and network newsletters and newspapers (such as the network's two-page protocol summaries), the network website, professional science newsletters, and Park Science.

4.7 Metadata and Data Storage Procedures

4.7.1 Metadata Procedures

The NPS GIS Committee requires all NPS GIS data layers be described with the NPS Metadata Profile, which combines the FDGC standard, elements of the ESRI metadata profile, the Biological Data Profile, and NPS-specific elements. Although no standard has been applied to natural resource databases and spreadsheets, the SFAN will complete the NPS Metadata Profile to the greatest extent possible to document the Pinnacles NM wetland monitoring database.

A complete metadata record for the wetland monitoring database will be generated in compliance with current NPS standards by the network Data Manager. Because the location data for this project is stored as UTM coordinates within the MS Access databases, there are no spatial data products associated with this protocol that require metadata records.

When completed, metadata records, but not the data themselves, will be posted to the NPS Data Store for public discovery and consumption. Contact information within the metadata records will direct interested parties to the network Data Manager for further inquiries. Master database metadata records posted to the NPS Data Store will be updated after a new set of monitoring data have been entered and certified or following database revision to a new version whole number (*i.e.*, v1_3 to v2_0, but not v2_0 to v2_1).

4.7.2 Data Storage

Although data may be temporarily stored at network parks during the data collection season, ultimate data storage - that is, archival storage of long term data - is at Golden Gate National Recreation Area where the Network Program Manager and Data Manager are stationed. The database is transferred to Golden Gate NRA each time a new set of monitoring data is certified in the database or the database is converted to a new version number. The Golden Gate NRA copy of the active master database is stored at:
Inpgogamahe1\Divisions\Network I&M\Individual Vital Signs\Wetlands\data

Previous database copies or versions will be archived at GOGA at:
Inpgogamahe1\Divisions\Network I&M\IM_Archive\VS_Indicators\Wetlands\data

4.8 Frequency of Review of Protocol Effectiveness

Monitoring programs are an effective use of public funds when they are carried out as planned and when the data are used to improve management of resources. Without frequent review of the monitoring program's feasibility and the management implications of the data, a monitoring program is a misallocation of scarce natural resource funds.

At the end of each data-collection season and after release of a draft End of Year Report, the Principal Investigator / Project Coordinator will meet with monument managers and network staff to formally present the results of the monitoring program to-date. The Coordinator will review the current year's data and show any changes in monument resources revealed by comparison of data from multiple years. The Coordinator will request from the managers suggestions for needed changes to the program and initiate a discussion about management implications of the data. This discussion will be summarized in writing in an addendum to the End of Year Report and presented with the final End of Year Report to the monument superintendent and managers and network staff. In particular, after the first full year of data collection, the protocol may warrant moderate revision, based on a full dataset and the experience of a full field season; the Principal Investigator / Project Coordinator will address issues raised in section 3.6 and present recommendations for change in the End of Year Report. In future years, once the Principal Investigator / Project Coordinator can evaluate data trends, the Coordinator will also consider if trend data suggest modifications to the protocol to improve effectiveness.

In subsequent years, the Principal Investigator / Project Coordinator will review previous years' suggestions for changes to the program and management, evaluate whether or not suggested changes had been implemented, and, if so, whether the changes affected the desired results.

5 - Personnel Requirements and Training

5.1 Description of Personnel and their Roles

5.1.1 San Francisco Bay Area Network Program Manager

The Network Program Manager provides ultimate oversight for this project: the Network Program Manager hires and supervises the Principal Investigator / Project Coordinator and Network Data Manager, manages overall funds for the project, ensures that data collection occurs in the appropriate years for the protocol, ensures that the protocol is updated as needed, and ensures that periodic reports are completed to appropriate standards and disseminated. The Network Program Manager's time dedicated to this project is funded out of network base funding.

5.1.2 San Francisco Bay Area Network Data Manager

The Data Manager maintains and updates the database for storing project data. The Data Manager also conducts end-of-year quality control and quality assurance on data, to ensure that any data errors can be corrected before field staff leave at the end of each data-collection season. The Data Manager's time dedicated to this project is funded out of network base funding.

5.1.3 Project Coordinator

The Principal Investigator / Project Coordinator is responsible for implementation of the protocol during each data-collection season. The Principal Investigator / Project Coordinator reviews and updates the protocol (if necessary) in the late winter or early spring of each data-collection year; assembles needed equipment, vehicle, and datasheets; coordinates with monument staff to arrange for local housing and park-specific training of field staff; and conducts hiring of field observers. The Principal Investigator / Project Coordinator works with monument staff to ensure that any necessary permits are acquired prior to field work. However, permitting is expected to consist only of acquisition of park-level permission of field personnel to travel in monument stream corridors and collect a minimal amount of plant material for identification. The Principal Investigator / Project Coordinator trains and supervises the field observers and travels to Pinnacles NM at least twice during the field season for training and data-quality assurance.

The Principal Investigator / Project Coordinator reviews data weekly during the data-collection season, and corrects any problems with data quality. The Principal Investigator / Project Coordinator summarizes and analyzes the data at the end of each data-collection season, and completes annual reports and trend reports for review by the Network Program Manager, Data Manager, and monument staff. At the end of each data-collection season the Principal Investigator / Project Coordinator cleans and stores equipment and replaces damaged equipment; reviews and updates the protocol as needed; and works with the Data Manager to ensure that data are appropriately stored.

The Project Coordinator's time dedicated to this project is wholly funded out of this monitoring project's funding.

5.1.4 Biological Science Technician (Botany)

The Botany Technician is responsible for one-half of data collection and data entry during the ten week data-collection season and will work closely with the Hydrogeomorphology Technician throughout the summer. The Botany Technician will receive one-week of training on implementation of the protocol during the beginning of the field season; during this time the Technician will review the protocol and get clarifications about any aspects of the work that are unclear. The Botany Technician must have an ability to identify (or key) vascular plants at Pinnacles NM, an ability to identify wetland plants and indicators of wetland hydrology, and an ability to apply Pinnacles NM's vegetation community classification to identify vegetation communities of the monument's stream channels. The Technician must have also have the ability to navigate to sites using a GPS unit and collect geographic coordinates with a GPS unit. The Technician is responsible for data entry for data related to vegetation and wetlands (*i.e.*, those data on the Botany Datasheets). The Botany Technician's time dedicated to this project is wholly funded out of this monitoring project's funding.

5.1.5 Physical Science Technician (Hydrogeomorphology)

The Hydrogeomorphology Technician is also responsible for one-half of data collection and data entry during the ten week data-collection season and will work closely with the Botany Technician throughout the summer. The Hydrogeomorphology Technician will also receive one-week of training on implementation of the protocol during the beginning of the field season and be expected to review the protocol. The Hydrogeomorphology Technician must have an ability to classify stream channels according to the Rosgen channel classification system, identify bankfull elevations in the field for the types of streams at Pinnacles NM, and recognize geomorphic features indicative of active aggradation and degradation of stream channels. The Technician must have also have the ability to navigate to sites using a GPS unit and collect geographic coordinates with a GPS unit. The Technician is responsible for data entry for data related to reach condition (*i.e.*, those data on the Reach Condition Datasheets). The Hydrogeomorphology Technician's time dedicated to this project is wholly funded out of this monitoring project's funding.

5.2 Training Procedures for Personnel

At the beginning of each data collection season the Principal Investigator / Project Coordinator will conduct one week of training with the field technicians. The training will seek to improve the technicians' abilities with respect to the following skills:

- Pace 25- and 100-meters accurately and consistently in a variety of stream conditions (see SOP 5)
- Identify bankfull elevation accurately and consistently (see SOP 5)
- Classify stream channels by the Rosgen stream classification system (see SOP 5)
- Estimate foliar cover of plant layers and dominant plant species (see SOP 5)
- Estimate plant heights in height classes (see SOP 5)
- Identify monument plant species by sight and with plant keys
- Identify vegetation communities, according to monument vegetation classification system (see SOPs 5 and 7)

- Evaluate presence/absence of plants at a point sample using point-sampling tool and densitometer (see SOP 5)
- Rate stream channels at Pinnacles NM with the CRAM metrics adopted for this protocol (see SOP 5)
- Identify monument Weed Watch and Wildlife Watch species by sight (see SOP 8)
- Use GPS unit to navigate to stored coordinates and record locations
- Use an electronic rangefinder to measure the distance across a channel between bankfull banks
- Record data onto datasheets with minimal error, enter data into a database with minimal error, and check database entries to evaluate error rate (see SOP 4)
- Use monument radio appropriately for communication with staff when needed and for emergencies

After the training week observers will begin data collection, with continued substantial support from park staff and the Principal Investigator / Project Coordinator.

Determining channel bankfull banks is an important skill for this position. The Hydrogeomorphology Technician should have some coursework or prior field experience with this task. Personnel should acquaint themselves with techniques for identifying bankfull width by watching USFS training video on this topic (USFS 1995) and discussing in the field with monument and network resource managers, preferably with a network hydrologist.

The ability to identify common plants of the monument by sight is a critical skill for the Botany Technician. This technician should have extensive coursework or (preferably) prior field experience in identification of California flora. Both technicians should work closely with monument personnel throughout the data-collection season to acquaint themselves with the monument's flora.

6 - Operational Requirements

6.1 Facility, Vehicle, and Equipment Needs

Implementation of this protocol requires a minimal amount of infrastructure support:

- The protocol's two field technicians will require limited office space at the monument during the eleven weeks (see section 6.3) required for training and implementation. Office space and a computer (may be a shared computer, not dedicated to this project) will be needed in mornings and evenings for communication and data entry. Office space will also be needed for storage of field equipment.
- Ideally, field staff will have the option to live in monument temporary-employee housing during the eleven weeks of training and field work.
- Field staff will require the use of one monument radio during the eleven-week field season.
- Field employees require a dedicated vehicle for the entire eleven-week field season to access trailheads throughout the monument.
- Project oversight will be the responsibility of network staff (*e.g.*, the network vegetation ecologist or water quality specialist). Although this Coordinator will not require project-specific office space or computer support, the Coordinator will require funds for travel to Pinnacles NM approximately two times during the field season. The Coordinator will, ideally, stay in monument employee or researcher housing during work trips.

6.2 Summary of Key Partnerships

6.2.1 San Francisco Bay Area Network of National Parks

The network has responsibility for general project oversight and protocol management. Project oversight includes hiring, training, and supervision of field personnel; ensuring that data are correctly gathered, stored, and summarized; and reporting of results. Protocol management includes periodic evaluation and updating of the monitoring protocol.

6.2.2 Pinnacles National Monument

Monument staff – particularly the Chief of Resources Management for the Monument - have responsibility for providing office space, park-specific training (*e.g.,* emerging safety issues, preventing of transportation of invasive species, radio use), and providing review comments on the protocol and reports. Monument staff will also ensure that the Principal Investigator / Project Coordinator and field technicians have adequate permissions and permits to conduct fieldwork in the monument where necessary, which may include incidental trampling of riparian vegetation and collection of a small number of plant specimens for office-based identification.

The network and monument will coordinate closely before, during, and after the field season to ensure that field personnel have access to the monument and needed infrastructure, that data are collected in a manner consistent with monument regulations, and that data and reports will be useful for addressing monument management concerns.

6.3 One-year Schedule for Fieldwork

6.3.1 Estimate of Time to Complete Protocol

Based on collection of pilot data using the draft protocol, the authors conservatively estimate that field crews can cover 1.5 kilometers per 10-hour workday, collecting information for fifteen 100-meter reaches and five transects. To cover the 47-kilometer stream network would require 31 10-hour workdays. However, some reaches are remote and will require considerable travel time, either on foot or by automobile. An allowance of 25% of the base estimate for travel and data entry suggests that the protocol can be completed with 40 10-hour days for two field technicians - or 10 weeks. One additional week for training and orientation is required.

6.3.2 Example of a One-year Schedule

Table 6.1. Example one-year schedule.

Task	Number of Weeks	Dates
Hiring, Monument Coordination, and Preparation: Principal Investigator / Project Coordinator (approximately 80 hours total)[1]	16	January to April
Orientation and Training: Technicians (40 hours each)[2, 3] and Principal Investigator / Project Coordinator (40 hours)	1	First week of May
Field Data Collection and Data Entry: Technicians (40 hours each per week)[2, 3]	10	Second week of May to mid-July
Supervision and Weekly Validation of Data: Principal Investigator / Project Coordinator (average 8 hours per week)	10	Second week of May to mid-July
Completion of End of Year Report: Principal Investigator / Project Coordinator (40 hours per week)	2	Mid-July to August

[1]Project Coordinator: total of 280 hours
[2]Botany Field Technician: total of 440 hours
[3]Hydrogeomorphology Field Technician: total of 440 hours

6.4 One-year Budget

The following is an example budget for one data-collection year, calculated with Fiscal Year 2009 wages for the San Francisco Bay Area locality pay rate. The budget assumes that for the first year of implementation the project would require a GS-12 Principal Investigator / Project Coordinator (Marie Denn), a GS-07 Seasonal Biological Science Technician (for Botany), and a GS-05 Seasonal Physical Science Technician (for Hydrogeomorphology). Benefits are included and estimated at 35% for the Principal Investigator / Project Coordinator and 7.5% for the

Technicians. After the first implementation year, after the protocol has gone through one full field year and revision, much of the work of the GS-12 Principal Investigator / Project Coordinator may be undertaken by a lessor-graded employee. Other position grades may also be adjusted in the future based on additional information about level of skill needed to implement the protocol and funding availability.

Feasibility of the protocol depends on the availability of support from the Network Inventory and Monitoring Program Manager and Data Manager; 30% of the cost of the program will be data management, analysis, and reporting by the Program Coordinator (included in Table 6.2) and the Network Data Manager (salary estimated in Table 6.2), with support from the Network Inventory and Monitoring Program Manager (salary estimated in Table 6.2).

Data management will require approximately 50% of the Project Coordinator's time ($4,960), 15% of each of the technicians' time ($2,764 total), approximately 80% of the bugeted Network Program Manager's time ($1,680), and all of the budgeted Network Data Manager's time ($4,000). Approximate total amount of the budget allocated to data management is $13,404, or about 37% of the budget total.

Table 6.2. Example one-year budget

Employee/Other	Grade/Step	Hourly Wage	Number of Hours	Total
Project Coordinator	GS-12/04	$43.22 + 35% benefits	170	$9,919
Biological Science Technician	GS-07/01	$21.55 + 7.5% benefits	440	$10,193
Physical Science Technician	GS-05/01	$17.40 + 7.5% benefits	440	$8,230
Network Program Manager			40	$2,100
Network Data Manager			80	$4,000
Vehicle				$1,500
Coordinator Travel				$500
Total				**$36,442**

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Appendix A: 2009 Pilot Data

Between 8 June and 12 June 2009 San Francisco Bay Area Network staff conducted a pilot study to evaluate and refine the draft monitoring strategy for riparian areas and wetlands associated with stream channels in the monument. This Appendix presents data collected during the pilot study. Implications of the data for the final design of the monitoring protocol are described in sections 2.6 and 4.4 of the Protocol Narrative. The transects visited during the pilot study will not be used in long-term monitoring. The information gained from the pilot study is used to inform decisions on the final survey design and data collection procedures.

Pilot study design data

The target populations are a) the entire set of 25-meter segments within the target stream network, b) the entire set of 100-meter reaches within the target stream network, and c) a set of transects laid perpendicular to the stream channel within the bankfull banks spaced randomly at about 300 meters apart along the entire target stream network. The target stream network are all those streams at Pinnacles National Monument with catchments of 3 square kilometers or greater. Network staff collected data at 32 reaches, comprising approximately 7% of the possible 466 stream reaches in the potential data collection area. Data were collected within four streams: Middle Chalone, North Wilderness, Frog, and Regan. These streams were subjectively chosen to represent the diversity of stream and vegetation types of the 12 streams within the sampling frame (see Table 2.1 in section 2.2.1 of the Protocol Narrative) for this pilot data-collection effort.

Each of the thirty-two 100-meter reaches contains four contiguous 25-meter segments. Network staff recorded the presence/absence of each wetland type within each segment and estimated the abundance of wetlands according to the size class system referenced in 2.2.2.1 of the Protocol Narrative. Network staff characterized each reach according to the Rosgen stream classification system (SOP 5, section SOP 5.8), and noted anthropogenic disturbance as described in SOP 5, section SOP 5.7. In addition, observers evaluated the condition of the reach according to the CRAM-derived metrics described in SOP 5, section SOP 5.6.

Table A.1. Summary of 100-meter reach pilot data.

Stream	Rosgen Types	Average Bankfull Width (m, standard deviation)		Very Tall Dominants (% cover, standard deviation)		Tall Dominants (% cover, standard deviation)		Medium Dominants (% cover, standard deviation)		Short Dominants (% cover, standard deviation)		Number of Habitat Patches	Percentage of 25-meter segments with wetlands
Middle Chalone	B2, B3	5.33	1.32	9.92	9.08	1.33	1.63	0.33	0.52	35.50	18.84	6.67	66%
North Wilderness	B2, G2	1.32	0.21	0	0	0	0	1.92	3.01	59.58	7.38	5.33	92%
Frog	A2, B2, B3	2.61	0.65	14.50	16.59	1.00	3.16	1.25	2.66	7.63	3.57	9.60	18%
Regan	C5, D5, F5, G3, G5	2.06	0.37	14.00	21.20	0	0	0.50	1.58	50.00	23.45	4.50	0%

Table A.2. 100-meter reach pilot data

Reach	VegCommunity	Rosgen	Number of channels	Bankfull (m)	VeryTallDom (%)	TallDom (%)	MediumDom (%)	ShortDom (%)	CRAM: Buffer	CRAM: Stability	CRAM Stability Tendency (A, D, or E)	CRAM: Patches	CRAM Topographic Complexity	CRAM: Horizontal Veg Complexity	CRAM: Vertical Veg Complexity	Disturbance Types	Wetland 0-25m	Wetland Type	Wetland 25-50m	Wetland Type	wetland 50-75m	Wetland Type	Wetland 75-100m	Wetland Type
Middle Chalone																								
1	PISA/ ERFA	B3	1	6.4		2	1	9	C	C	A	6	A	C	D	1/5/6/1 1/14/2 2								
2	PISA/ ERFA	B3	1	6.4	3.5			20	C	C	A	5	B	C	D	1/5/6/1 1/14/2 2/30								
3	PISA/ ERFA	B2	1	6.0	7		1	34	C	B	A	5	B	C	D	1/5/6/1 4/22	1	PEMC	4	PEMC	4	PEMC	4	PEMC
4	BASA	B2	1	5.8	12			60	C	B	E	7	A	B	B	1/5/11/ 14	4	PEMC	4	PEMC	4	PEMC	4	PEMC
5	BASA	B2	1	3.2	11	2		50	C	B	A	7	A	B	C	1/5/11/ 14	4	PEMC	4	PEMC	4	PEMC	4	PSSC
6	BASA	B2	1	4.2	26	4		40	C	C	D	10	A	B	C	1/5/11/ 14	4	PSSC	4	PSSC	4	PSSC	4	PSSC
North Wilderness																								
1	ELMA	G2	1	1.4			6.5	72.5	C	C	D	6	C	C	D	1/5/14/ 17	2	PEMC			3	PEMC	3	PEMC
2	ELMA	B2	1	1.3				60	C	B	D	5	B	C	D	5/11/1 4/17	4	PFOC	4	PEMC	4	PEMC	3	PEMC
3	ELMA	B2	1	1.2				60	C	B	D	5	B	C	D	5/11/1 4/17	3	PEMC	3	PEMC	4	PEMC	4	PEMC
4	ELMA	B2	1	1.2			5	50	C	B	E	7	B	C	D	1/5/11/ 17/29	3	PEMC	4	PEMC	3	PEMC	2	PEMC
5	ELMA	B2	1	1.7				59	C	B	D	4	B	C	D	1/5/11/ 14/17	4	PEMC	4	PEMC	4	PEMC	4	PEMC
6	ELMA	B2	1	1.1				56	C	B	D	5	B	C	D	1/5/11/ 14/17	2	PEMC	2	PEMC	3	PEMC		
Frog Canyon																								
1	PISA/ ERFA	B2	1	3.1					A	B	E	6	A	A	B	5								
2	PISA/ ERFA	B3	1	3.4				8	A	B	E	7	A	A	B									

Table A.2. 100-meter reach pilot data (continued).

Reach	VegCommunity	Rosgen	Number of channels	Bankfull (m)	VeryTallDom (%)	TallDom (%)	MediumDom (%)	ShortDom (%)	CRAM: Buffer	CRAM: Stability	CRAM Stability Tendency (A, D, or E)	CRAM: Patches	CRAM Topographic Complexity	CRAM: Horizontal Veg Complexity	CRAM: Vertical Veg Complexity	Disturbance Types	Wetland 0-25m	Wetland Type	Wetland 25-50m	Wetland Type	wetland 50-75m	Wetland Type	Wetland 75-100m	Wetland Type
3	PISA/ ERFA	B3	1	2.2				16	A	B	A	10	A	A	B	5								
4	PISA/ ERFA	B3	1	2.2				5	B	B	E	10	A	A	A	5								
5	PLRA/ QUAG	A2	2	2.2	20			7.5	A	A	E	7	A	A	B				2	PPBC	3	PPBC		
6	ASCA	A2	2	3.1	9	10		7	A	A	E	11	A	A	A	5			4	PPBC	3	PPBC	4	PPBC
7	PARA/ QUAG	A2	1	1.4	25			5.5	A	A	E	10	A	A	A				1	PUBC				
8	PARA/ QUAG	A2	1	2.3	52			5	A	A	E	9	A	A	A									
9	PARA/ QUAG	B2	1	3.4	17.5		5.5	7	A	B	E	13	A	A	A				2	PUBC				
10	PARA/ QUAG	A2	1	2.8	21.5		7		A	A	E	13	A	A	A		1	PEMC						
Regan																								
1	Unk herbac eous	G3	1	2.3				75	C	C	D	1	B	D	D	4/5/6								
2	Unk herbac eous	G3	1	2.2				70	C	C	D	3	B	D	D	4/5/6/7								
3	QUDO/ PISA	G5	1	1.3	30			75	C	B	A	5	B	D	C	4/5/6/2 9/11								
4	QUDO/ PISA	G5	1	2.1	8			50	D	B	A	5	B	C	C	4/5/6								
5	Unk herbac eous	F5	1	2.5				30	C	B	E	3	B	C	C	4/5/6								
6	Unk herbac eous	F5	1	2.5				30	C	B	A	7	B	D	D	4/5/6								
7	Unk herbac	F5	1	1.8				30	C	B	E	3	B	D	D	4/5/6/1 7/27								

Table A.2. 100-meter reach pilot data (continued).

Reach	VegCommunity	Rosgen	Number of channels	Bankfull (m)	VeryTallDom (%)	TallDom (%)	MediumDom (%)	ShortDom (%)	CRAM: Buffer	CRAM: Stability	CRAM Stability Tendency (A, D, or E)	CRAM: Patches	CRAM Topographic Complexity	CRAM: Horizontal Veg Complexity	CRAM: Vertical Veg Complexity	Disturbance Types	Wetland 0-25m	Wetland Type	Wetland 25-50m	Wetland Type	wetland 50-75m	Wetland Type	Wetland 75-100m	Wetland Type
	eous																							
8	Unk herbaceous	G5	1	1.9	7		5	70	C	B	A	6	B	C	D	4/5/6								
9	SALA/ARDO	C5	1	2.0	63			60	C	B	A	7	B	B	B									
10	SALA/BASA	D5	1	2.0	32			10	C	B	A	5	B	B	B	4/5/6								

Transect Data

Network staff collected data for 10 cross-channel transects (representing 6.5% of the possible 155 transects in the data collection area), in four streams in the monument (please see figure 3.2 for transect and reach configuration). Observers collected data regarding Tree/Shrub cover (and species identification), graminoid cover, herbaceous plant cover, algal mat cover, litter cover, exposed bedrock cover (*i.e.,* rocky channelbed material with short-axis diameters of greater than 309 millimeters (Bunte and Abt 2001)), size of mobile rocky channel bed substrate (*i.e.*, material with short-axis diameter less than 309 millimeters), and channel width. The average number of plant guilds per point on the transect was calculated after completion of fieldwork.

Table A.3. Summary of transect pilot data

Reach	Tree/Shrub Cover	Graminoid Cover	Herb Cover	Algae Cover	Litter Cover	Number of Plant Guilds	Exposed Bedrock Cover	Mobile Substrate (average particle size in mm on small axis of particle)	Bankfull Channel Width (m)
MiddleChalone1	0.06	0.06	0.00	0.00	0.15	0.25	0.09	52.4	6.40
MiddleChalone4	0.62	0.52	0.14	0.00	0.76	2.05	0.00	24.84	6.10
NorthWilderness3	0.00	0.64	0.09	0.09	0.36	1.09	0.27	99.9	1.00
NorthWilderness6	0.00	0.31	0.08	0.00	0.92	1.30	0.31	10.91	1.20
Frog3	0.00	0.00	0.00	0.00	0.29	0.30	0.00	66.46	3.00
Frog6	0.69	0.06	0.00	0.00	0.19	0.90	0.56	17.58	1.50
Frog9	0.50	0.04	0.00	0.00	0.64	1.20	0.00	36.82	3.10
Regan1	0.00	0.16	0.11	0.00	0.74	0.90	0.00	4.76	1.80
Regan4	0.00	0.33	0.00	0.00	0.48	0.80	0.00	2.80	2.00
Regan7	0.92	0.00	0.00	0.00	1.00	1.90	0.00	2.00	2.50
Summary Statistics									
Transect Mean	0.28	0.21	0.04	0.01	0.55	1.07	0.12	31.85	2.86
Transect Standard Deviation	0.36	0.23	0.06	0.03	0.30	0.59	0.19	32.38	1.92

Conclusions

The following is an informal discussion of changes made to the protocol as a result of pilot data collection:

- We did not create GPS locations for the pilot transects, because we had originally envisioned these to be not permanent. However, we realized in the field that there is too much variability between transects to show changes if we group them all together and then repositioned them in subsequent years. Therefore so we altered our protocol to require permanent transect placement. This was not without some hesitation, as we knew this would consign future observers to finding these locations again, which will take more time than picking new locations. There should be no “trampling bias” from re-visiting the same transects each data-collection cycle because a) data-collection occurs only every third year, and b) data collection occurs in a high-disturbance habitat (*i.e.*, in the creek channel) where annual flooding will move bed material and encourage plant regeneration. We tested the re-location of the concept by marking GPS locations and then navigating back to them, but the pilot data represented in Appendix A does not have known locations.

- We started pilot data collection without observations of "non-native grass assemblages" or "deepest pool depth" then midway through the pilot added those metrics for the data collection for the 100-meter reaches, due to our field observations and park staff request (respectively). Therefore, we have some pilot data for those metrics but I did not include these in Appendix A because we did not have data for reaches observed. However, we're discontinuing those metrics, due to reviewer concerns that we have too much ancillary data and also discontinuing the "disturbance" identification.

- During pilot data collection we estimated the size of wetlands in each reach; due to reviewer comments that metric has been discontinued.

- During pilot data collection we changed the method by which we calculate the number of points to read across each transect. We tried out several algorithms in the field to come up with consistent rules that would result in observers collecting enough points in narrow channels to characterize the vegetation and channel bed materials while also avoiding spending an excessive amount of time collecting points across the wide washy channels that can be well characterized with a few dozen observations.

Literature Cited

Bunte, K. and S. R. Abt. 2001. Sampling surface and subsurface particle-size distributions in wadable gravel-and cobble-bed streams for analyses in sediment transport, hydraulics, and streambed monitoring. US Department of Agriculture, US Forest Service, Rocky Mountain Research Station General Technical Reference RMRS-GTR-74, Fort Collins, Colorado. Online. (www.fs.fed.us/rm/pubs/rmrs_gtr74.html). Accessed 1 March 2010.

Appendix B: Analysis of Simulated Data

Figures

Page

Tables

Page

This appendix simulates multi-year analysis of data that will be generated by this monitoring protocol. Not all possible data sets that will come out of this protocol have been simulated (*i.e.*, we have not simulated a data set for each possible metric). Two sets of simulated data represent what the linear regression analysis for parametric datasets from this protocol may resemble, while one simulated dataset represents what the logistic regression analysis for binary datasets may resemble. These simulated data have been created with random number generators in Microsoft Excel and from the on-line binomial number generator at www.random.org. Simulated data are presented merely to show the type and interpretation of data analyses; they are not modeled on expected data. Please see table 4.3 in the protocol for a summary of types of datasets expected from this protocol and proposed multi-year analyses. Analyses and graphs (Figures B1-B3) were created in the R statistical package using functions “lm” for linear regression, and “glm” for logistic regression. The code for these analyses is reproduced below each graph along with the interpretation for managers. The simulated data is reproduced in a table at the end of the Appendix.

Simulated Data for Bankfull Width and Forb Cover

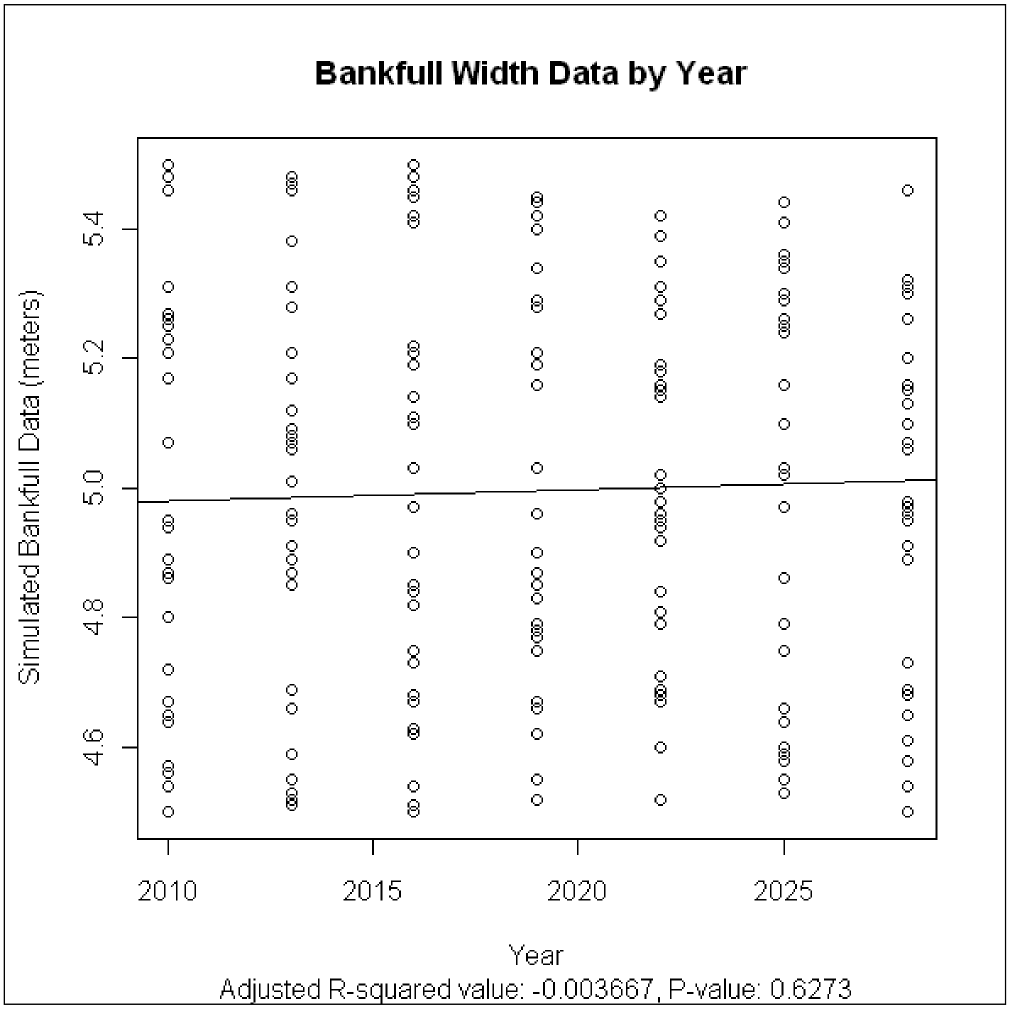

Figure B.1. Simulated data for bankfull width and forb cover analyzed via linear regression (R software).

Interpretation from Simulated Data

Interpretation from simulated data: Between 2010 and 2028 the monitoring program did not find any statistically-significant change in bankfull widths of channels at Pinnacles NM (threshold significance value set at 0.10, calculated P-value was approximately 0.63, therefore the trend was not statistically significant). Based on this channel geomorphology data, we cannot conclude that there has been a change in the channel-forming processes at Pinnacles NM.

Plots for actual data should be produced with data summarized either in box plots or averages with confidence interval bars, rather than as individual data points (as shown here with 30 data points per year), as there will be too many data points to plot distinctly.

Code for R Statistical Software Package

```
fit <- lm(bankfull ~ year)
summary(fit)
# non-command line: insert R-squared value and P-value data from summary into submain title in
the command line below
plot(year, bankfull, main="Bankfull Width Data by Year ",sub="Adjusted R-squared value:0.0034, P-
value:0.35", xlab="Year", ylab="Simulated Bankfull Data (meters)")
abline(fit)
# non-command line: where "bankfull" is bankfull data vector, and "year" is year data vector
```

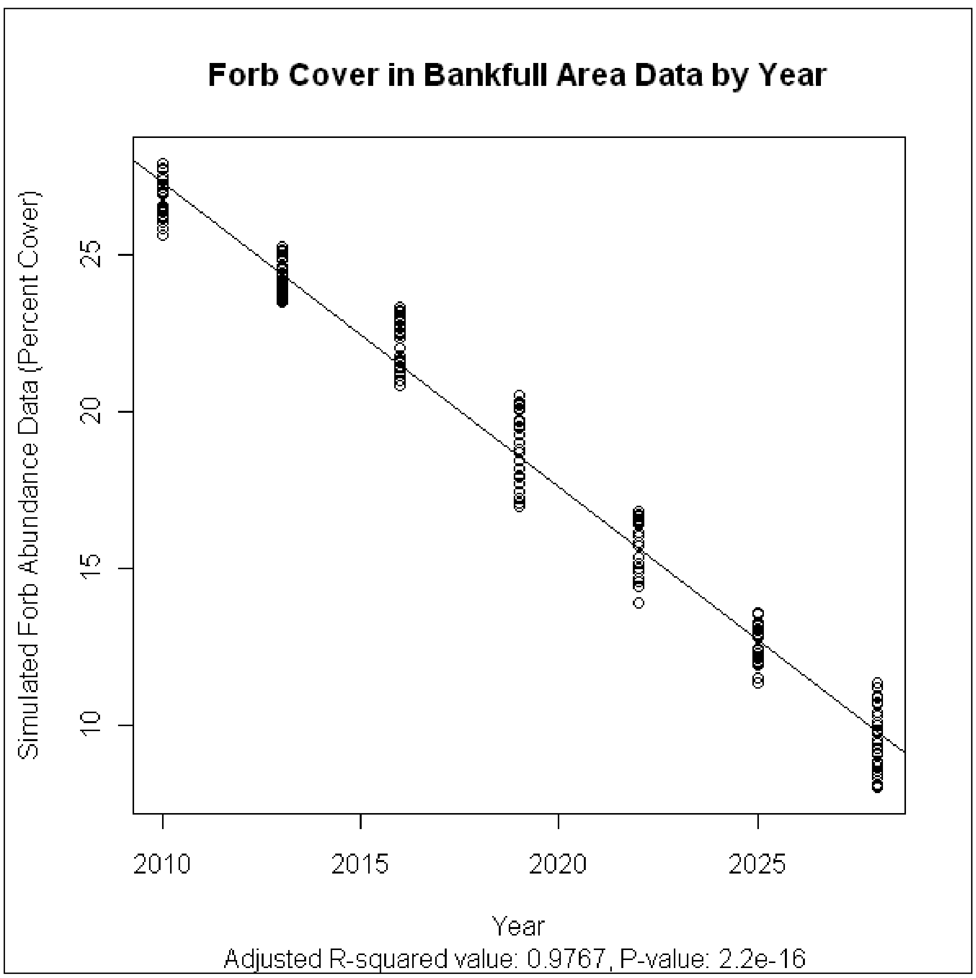

Figure B.2. Forb cover in bankfull area data by year.

Interpretation from Simulated Data

Interpretation from simulated data: Between 2010 and 2028 the monitoring program found a statistically-significant change in the percent cover of forb species within the bankfull area of channels at Pinnacles NM (threshold significance value set at 0.10, calculated P-value was much less than that, therefore the trend was statistically significant). We conclude that there has been some change in physical or biological processes at Pinnacles NM that has resulted in this change. Park managers should investigate the causes of this change and the biota that may be affected.

Code for R Statistical Software Package

```
fit <- lm(forb ~ year)
summary(fit)
# non-command line: insert R-squared value and P-value data from summary into submain title in
the command line below
plot(year, forb, main="Average Forb Cover in Bankfull Area by Year ",sub="Adjusted R-squared
value: 0.8723, P-value: 0.0001419", xlab="Year", ylab="Simulated Forb Abundance Data (Percent
Cover)")
abline(fit)
# non-command line: where "forb" is forb data vector, and "year" is year data vector
```

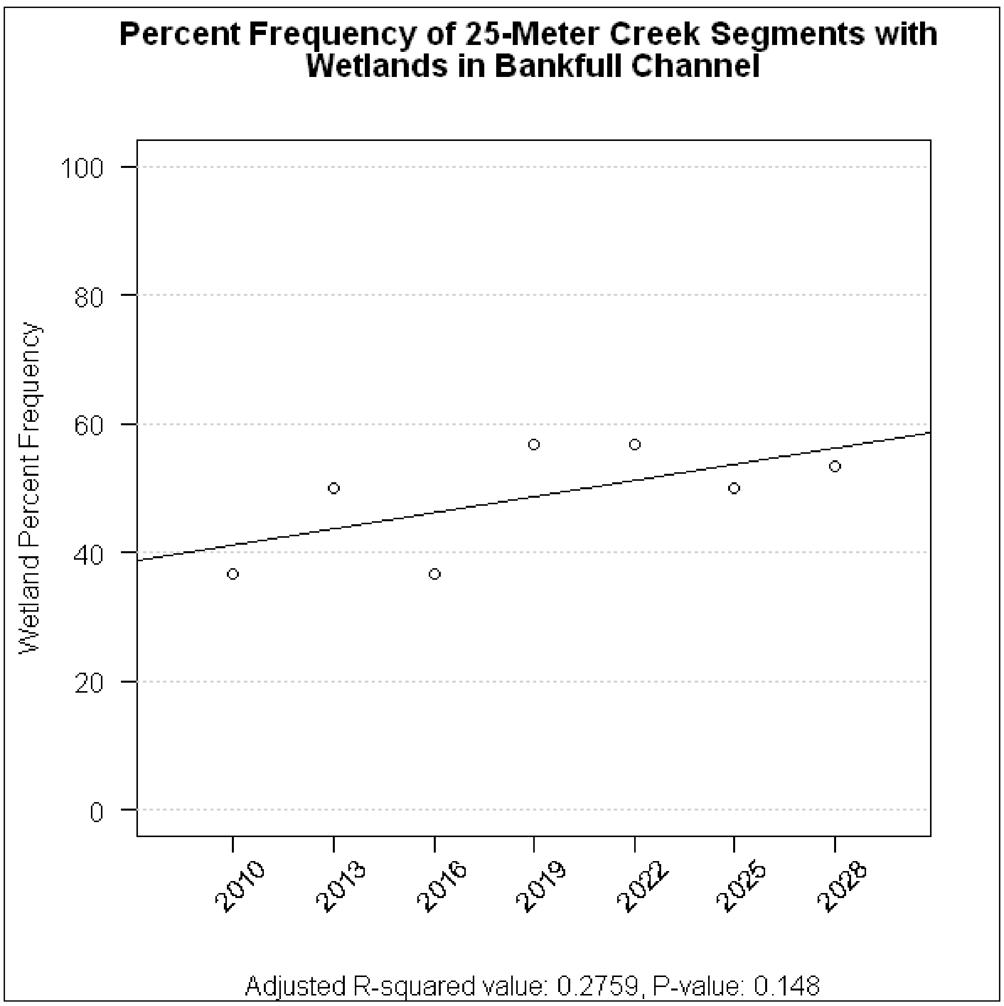

Figure B.3. Simulated bankfull width data and forb cover analyzed via logistic regression (R software).

Interpretation from Simulated Data

Interpretation from simulated data: Between 2010 and 2028 the monitoring program did not find any statistically-significant change in frequency of wetlands observed in 25-meter segments of creek at Pinnacles NM (threshold significance value set at 0.10, calculated P-value was 0.148, therefore the trend was not statistically significant). We cannot conclude that there has been a change in abundance of in-channel wetlands at Pinnacles NM.

No error bars are shown in graph, as each year's data represents an entire census of the 25-meter channel segments within the sample frame. The P-value shown represents a logistic regression analysis of all raw binomial data (not summarized by year) using the glm function for logit analysis in the R statistical package.

Code for R Statistical Software Package

```
fit1 <- glm (wetland ~ year, family=binomial(link=logit))
summary(fit1)
# non-command line: where "wetland" is wetland frequency data vector (as binomial data), and
"year" is year data vector
```

```
qpV1 = wetland$Hits[1]
npV1 = wetland$n[1]
xpV1 =2010
bpV1 = binom.confint(qpV1, npV1, conf.level=0.95, method="exact")
mpV1 = bpV1$mean*100
qpV2 = wetland$Hits[2]
npV2 = wetland$n[2]
xpV2 =2013
bpV2 = binom.confint(qpV2, npV2, conf.level=0.95, method="exact")
mpV2 = bpV2$mean*100
qpV3 = wetland$Hits[3]
npV3 = wetland$n[3]
xpV3 =2016
bpV3 = binom.confint(qpV3, npV3, conf.level=0.95, method="exact")
mpV3 = bpV3$mean*100
qpV4 = wetland$Hits[4]
npV4 = wetland$n[4]
xpV4 =2019
bpV4 = binom.confint(qpV4, npV4, conf.level=0.95, method="exact")
mpV4 = bpV4$mean*100
qpV5 = wetland$Hits[5]
npV5 = wetland$n[5]
xpV5 =2022
bpV5 = binom.confint(qpV5, npV5, conf.level=0.95, method="exact")
mpV5 = bpV5$mean*100
qpV6 = wetland$Hits[6]
npV6 = wetland$n[6]
xpV6 =2025
bpV6 = binom.confint(qpV6, npV6, conf.level=0.95, method="exact")
mpV6 = bpV6$mean*100
qpV7 = wetland$Hits[7]
npV7 = wetland$n[7]
xpV7 =2028
bpV7 = binom.confint(qpV7, npV7, conf.level=0.95, method="exact")
mpV7 = bpV7$mean*100
mean <- c(mpV1, mpV2, mpV3, mpV4, mpV5, mpV6, mpV7)
year <- c(2010, 2013, 2016, 2019, 2022, 2025, 2028)
plot (year, mean, ylim=c(0,100), xlim=c(2008,2030), ylab='Wetland Percent Frequency', xaxt='n',
xlab=' ', las=2, sub="Adjusted R-squared value: 0.2759, P-value: 0.148",)
grid (NA, ny = NULL, col = 'lightgray', lty='dotted', lwd = par('lwd'))
xlabpos=c(2010, 2013, 2016, 2019, 2022, 2025, 2028)
xticlab= c('2010', '2013', '2016', '2019', '2022', '2025', '2028')
axis(1, at=xlabpos, labels=FALSE)
text(xlabpos, par("usr")[3] - 4, labels=xticlab, srt=45, pos=1, xpd=TRUE)
title('Percent Frequency of 25-Meter Creek Segments with ', line=3)
title('Wetlands in Bankfull Channel', line=2)
```

```
fit <- lm(mean ~ year)
summary(fit)
abline(fit)
```

Simulated Data:

In the simulated dataset (Figure B4), each datapoint in the “bankfull” column represents a measurement from one 100-meter reach. Each year the protocol is implemented it should generate about 470 datapoints of this type. Only 30 datapoints per year are simulated in this dataset for brevity, however the analysis would be identical with a much larger number of datapoints. Also in this dataset, each datapoint in the “forb” column represents the average percent cover of forb species observed across one transect. Each year the protocol is implemented it should generate about 157 datapoints of this type, rather than the 30 datapoints per year presented in this simulated dataset. Again, analysis would be identical to that presented in this appendix irregardless of number of datapoints. Finally, each datapoint in the “wetlands” column represents an observation from one 25-meter segment of creek (1 = wetland present in segment, 0 = wetland not present in segment). Each year the protocol is implemented it should generate approximately 1,880 datapoints of this type, rather than the 30 datapoints per year simulated here; data should be analyzed as presented in this appendix.

Table B.1. Simulated data.

year	bankfull	forb	wetlands
2010	4.50	27.96	1
2010	4.50	27.95	0
2010	5.23	27.91	0
2010	5.50	27.80	0
2010	5.17	27.78	0
2010	4.57	27.73	1
2010	4.65	27.72	0
2010	5.46	27.53	0
2010	4.67	27.41	0
2010	5.26	27.39	1
2010	4.64	27.27	0
2010	4.72	27.13	1
2010	5.31	27.04	0
2010	4.54	26.98	1
2010	4.87	26.94	0
2010	4.86	26.57	1
2010	4.87	26.53	0
2010	4.89	26.51	0
2010	5.21	26.50	0
2010	5.27	26.43	0
2010	5.07	26.40	0
2010	5.50	26.36	0
2010	4.80	26.35	0
2010	4.95	26.29	1
2010	5.48	26.19	1
2010	4.64	26.16	1
2010	4.57	26.05	1
2010	4.94	26.05	0
2010	5.25	25.86	0
2010	4.56	25.64	1
2013	5.38	25.29	0
2013	5.07	25.16	1
2013	5.17	25.13	0
2013	5.09	25.12	1

year	bankfull	forb	wetlands
2013	4.87	25.03	0
2013	5.48	25.02	1
2013	4.59	24.93	0
2013	5.21	24.86	0
2013	4.52	24.64	0
2013	5.47	24.63	0
2013	4.95	24.61	0
2013	4.66	24.52	1
2013	4.89	24.42	1
2013	5.12	24.38	1
2013	4.55	24.22	1
2013	4.91	24.21	1
2013	5.08	24.17	1
2013	4.51	24.14	0
2013	5.46	24.08	1
2013	5.31	24.02	1
2013	5.28	23.97	1
2013	4.53	23.83	1
2013	5.06	23.82	0
2013	4.69	23.75	0
2013	4.66	23.70	0
2013	5.08	23.68	0
2013	4.96	23.59	1
2013	4.85	23.56	0
2013	5.28	23.53	0
2013	5.01	23.48	1
2016	5.48	23.33	1
2016	4.63	23.22	0
2016	5.19	23.18	0
2016	4.97	23.08	0
2016	5.22	23.00	0
2016	4.82	22.93	0
2016	4.67	22.90	0
2016	4.68	22.88	1
2016	5.03	22.71	1
2016	5.11	22.69	0
2016	4.50	22.57	0
2016	4.75	22.49	1
2016	5.42	22.44	1
2016	4.51	22.35	0
2016	4.73	22.03	1
2016	5.45	21.77	1
2016	4.84	21.68	1
2016	5.46	21.66	1
2016	5.21	21.64	0
2016	4.62	21.64	0
2016	4.54	21.60	0
2016	5.19	21.56	0
2016	5.50	21.48	0
2016	4.85	21.46	0
2016	4.90	21.43	1
2016	5.10	21.27	0
2016	5.14	21.24	0
2016	5.42	21.18	1
2016	5.41	21.00	0
2016	5.21	20.86	0
2019	4.52	20.54	1
2019	5.45	20.53	1
2019	4.83	20.52	1
2019	4.75	20.32	0

year	bankfull	forb	wetlands
2019	4.75	20.29	1
2019	5.16	20.21	0
2019	5.45	20.12	1
2019	5.34	20.07	0
2019	5.29	19.75	1
2019	5.28	19.73	1
2019	4.85	19.71	0
2019	4.87	19.69	1
2019	5.29	19.67	1
2019	5.40	19.55	1
2019	5.21	19.47	0
2019	4.96	19.27	1
2019	4.62	19.04	0
2019	4.90	18.81	1
2019	4.85	18.68	0
2019	5.44	18.46	0
2019	4.55	18.19	1
2019	4.77	17.98	1
2019	5.42	17.94	0
2019	4.67	17.74	0
2019	4.66	17.71	0
2019	4.79	17.45	0
2019	5.34	17.25	0
2019	4.78	17.24	1
2019	5.03	17.11	1
2019	5.19	17.01	1
2022	5.02	16.84	1
2022	4.79	16.81	0
2022	4.92	16.73	0
2022	4.94	16.65	0
2022	4.95	16.57	0
2022	5.42	16.51	0
2022	4.98	16.44	1
2022	5.35	16.42	1
2022	5.31	16.42	1
2022	5.00	16.40	1
2022	4.81	16.17	0
2022	4.67	16.06	1
2022	5.35	15.85	1
2022	5.18	15.74	0
2022	5.19	15.39	0
2022	5.16	15.18	0
2022	4.92	15.15	0
2022	5.39	15.02	1
2022	4.68	15.00	1
2022	4.84	14.99	1
2022	4.96	14.98	1
2022	4.95	14.91	0
2022	5.27	14.89	0
2022	4.52	14.70	1
2022	5.14	14.70	1
2022	5.29	14.67	1
2022	4.69	14.57	1
2022	5.15	14.57	1
2022	4.71	14.44	0
2022	4.60	13.93	1
2025	5.02	13.60	0
2025	5.25	13.53	0
2025	4.58	13.52	1
2025	5.34	13.28	0

year	bankfull	forb	wetlands
2025	4.55	13.22	1
2025	5.30	13.21	0
2025	5.29	13.21	0
2025	4.64	13.18	0
2025	4.97	13.08	1
2025	5.26	13.04	1
2025	4.97	12.93	1
2025	5.41	12.89	1
2025	5.44	12.86	0
2025	4.66	12.83	1
2025	4.75	12.47	0
2025	5.16	12.47	0
2025	4.60	12.40	0
2025	4.53	12.31	0
2025	5.36	12.30	0
2025	5.24	12.19	1
2025	4.86	12.17	1
2025	4.59	12.15	1
2025	5.10	12.13	1
2025	5.35	12.01	1
2025	5.03	12.00	1
2025	5.25	12.00	0
2025	4.75	11.95	1
2025	4.79	11.52	0
2025	5.30	11.50	0
2025	5.03	11.33	1
2028	5.30	11.33	1
2028	5.16	11.19	1
2028	4.50	10.96	1
2028	5.46	10.91	1
2028	5.10	10.86	0
2028	4.97	10.74	1
2028	5.31	10.68	1
2028	5.13	10.41	0
2028	4.91	10.39	0
2028	5.13	10.29	1
2028	4.89	10.12	0
2028	5.46	10.00	0
2028	4.54	9.83	0
2028	4.98	9.80	1
2028	5.10	9.72	1
2028	4.58	9.55	1
2028	4.68	9.42	0
2028	4.65	9.29	1
2028	5.32	9.11	0
2028	5.06	9.05	0
2028	4.95	8.83	1
2028	5.15	8.82	1
2028	4.96	8.71	0
2028	5.26	8.51	0
2028	5.20	8.45	0
2028	5.07	8.33	1
2028	4.61	8.33	0
2028	4.68	8.14	0
2028	4.73	8.09	1
2028	4.69	8.00	1

SOP 1. Protocol Review and Revision

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
-	September 2009	Denn, M.	Adopted from San Francisco Bay Area Network Early Detection Protocol	-	1.0

Tables and Appendixes

Page

Scope and Application

This Standard Operating Procedure explains how to make changes to the Pinnacles National Monument Riparian Habitat and Associated Wetlands Monitoring Protocol and accompanying SOPs, and explains procedures for tracking these changes. Network or park staff editing the Protocol Narrative or any SOP must to follow this procedure to eliminate confusion in data collection and analysis methods. All network and park staff implementing and reviewing this protocol should be familiar with this SOP in order to identify and use the most current methodologies.

This SOP also contains a table listing the most current version of the protocol narrative and each SOP. This will provide a single reference for ensuring that the most current documents in use. Also included will be a section containing comments from protocol review, responses to those comments and approvals.

Protocol Revision Procedures

1. The Pinnacles National Monument Riparian Habitat and Associated Wetlands Monitoring Protocol Narrative and accompanying SOPs designed to provide adequate documentation to ensure that differences between observers and observation years do not create bias in data collection. However, changes and revisions will inevitably be necessary based on new information; these changes will be documented as soon as they are deemed necessary and appropriate reviews conducted.

   All edits will be reviewed technical accuracy and overall clarity. Minor changes or additions to existing methods will be reviewed by relevant network and park staff. However, if a substantial change in methods is anticipated then an outside review is required. Subject matter experts familiar with wetland and riparian habitat monitoring and data analysis will evaluate the proposed changes.

2. Edits and protocol revisions will be documented in the Revision History Log that accompanies the Protocol Narrative and each SOP. Only changes in the Protocol Narrative or specific SOP that has been edited will be logged. Minor changes, such as an alteration of species lists, will be recorded as decimal increases in version number (*e.g.*, Version 1.1 to 1.2). Major changes, such as an alteration in objectives or update after five-year analysis, will be recorded as integer increases in version number (*e.g.*, Version 1.2 to 2.0). "Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number" (Peitz *et al.* 2002). Changes to conform to the most recent formatting required by NPS "Instructions to Authors" (NPS 2006) are generally completed as part of protocol revision and not noted separately as changes.

3. Notify the Network Lead Data Manager or Project Manager of any changes to the Protocol Narrative or SOP so that the new version number can be in the project database per any changes to the Protocol Narrative and SOPs.

4. Post new versions on the internet and notify all individuals known to have a previous version of the Protocol Narrative or SOP.

5. When any significant changes in the data collection protocols occur, such as changes in sample collection techniques or equipment, a change in database, or changes in staff, there should be an overlap of methods and personnel (Oakley *et al.* 2003). This requires using both the old and new techniques on a given survey as well as having both the outgoing and new staff survey concurrently.

Table SOP1.1. Current PINN Riparian and Associated Wetlands Monitoring Protocol documents.

Document Name	Current Version	Version Date	Author
Pinnacles National Monument Riparian Habitat and Associated Wetlands Monitoring Protocol Narrative	1.0	September 2009	Denn, M.
SOP 1: Protocol Revision and Review	1.0	September 2009	Denn, M.
SOP 2: Personnel Safety	1.0	September 2009	Denn, M.
SOP 3: Equipment and Field Preparations	1.0	September 2009	Denn, M.
SOP 4: Data Management and Quality Assurance	1.0	September 2009	Press, D.
SOP 5: Detailed Field Methods	1.0	September 2009	Denn, M., Ryan, A.B.
SOP 6: Procedure for delineating streams and watersheds based on monument Digital Elevation Model	1.0	September 2009	Denn, M.
SOP 7: Classifications for Wetlands and Riparian Areas, Lists of Wetland Plants, and Key to Plant Communities at Pinnacles National Monument	1.0	September 2009	Denn, M.
SOP 8: Weed and Wildlife Watch List and Reporting Procedures	1.0	September 2009	Denn, M., Johnson, P.J., Johnson, B.

Protocol Review

Appendix SOP 1 contains the PWR Protocol Review Checklist used by peer reviewers.

Review Approval and Distribution

Key personnel involved with the development, implementation, and review of this monitoring protocol will be on the electronic mailing list for receipt of this document and subsequent major revisions. These include the following personnel:

- Denise Louie, Chief of Resources Management, Pinnacles NM
- Marcus Koenen, Inventory and Monitoring Program Manager, San Francisco Bay Area Network
- Penny Latham, Inventory and Monitoring Program Manager, NPS Pacific West Region

Literature Cited

Oakley, K. L., L. P. Thomas, and S. G. Fancy. 2003. Guidelines for long-term monitoring protocols. Wildlife Society Bulletin 31:1000–1003.

National Park Service. 2006. Instructions to Authors—Natural Resource Report and Natural Resource Technical Report: Version 2.4. Natural Resource Report NPS/NRPC/NRTR—2006/001. National Park Service, Fort Collins, Colorado. Online. (https://science1.nature.nps.gov/naturebib/biodiversity/2007-6-5/Instructions_to_Authors.pdf). Accessed 2 March 2010.

Peitz, D. G., S. G. Fancy, L. P. Thomas, and B. Witcher. 2002. Bird monitoring protocol for Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas. Prairie Cluster prototype monitoring program.

Appendix SOP 1 A. PWR Protocol Review Checklist.

Section 1	Overall Organization and Presentation of Protocol Narrative
	1. Is the overall monitoring protocol well-organized with sections clearly delineated?
	2. Does the protocol have a title page with authors' names, protocol version number and date? (Protocol version numbers should be constructed to allow for both major and minor changes.) Is there a Table of Contents, abstract, and the three basic sections: 1-Narrative, 2-Standard Operating Procedures (SOPs), and 3-Supplementary Materials or Appendices recommended in the NPS standards published by Oakley *et al.* 2003 (http://science.nature.nps.gov/im/monitor/protocols/ProtocolGuidelines.pdf).
	3. Is there a complete and accurate table of contents with page numbers? (Chapters should be paginated consecutively, *i.e.*, Chap. 1 (pp. 1-20), Chap. 2 (pp. 21-28), Chap. 3 (pp. 29-44), *etc.* to allow for modular updates.)
	4. Are the tables and figures clearly labeled and understandable?
	5. Is the protocol bound so that it lies flat, preferably in a 3-ring binder?
Section 2	A. Background and Objectives (Chapter 1)
	1. Does the protocol narrative provide a rationale or justification for why a particular resource or resource issue was selected for monitoring? Is the history and background for this resource issue well-referenced with supporting literature cited?
	2. Does the protocol narrative discuss the linkages between this and other monitoring projects?
	3. Does the protocol narrative describe how monitoring results will inform management decisions?
	4. Does the protocol narrative contain careful documentation of the monitoring objectives or monitoring questions being asked?
	5. Does the protocol narrative identify specific measurable objectives such as thresholds or trigger points for management actions?
Section 3	B. Sampling Design (Chapter 2)

	1. Is there a clear and logical rationale for selecting the sampling design over others?
	2a. Were the criteria for site selection clearly discussed including stratification, spatial design, and whether this monitoring will be co-located and/or integrated with other VS monitoring protocols? (See Checklist, Section 1A2.)
	2b. Has the target population or "sampling frame", and the sampling units, been identified? In other words, is the desired level of inference clear?
	3. Is the sampling frequency and replication identified?
	4. Is the timing of sampling defined?
	5. Are the locations of sampling sites clearly identified?
	6. Is the level of change that can be detected for the amount or type of sampling being instituted identified? (See Checklist, Section 1A5.)
Section 4	C. Field Methods (Chapter 3)
	1. Are preparations for the field season and equipment setup included? Are requirements for permitting and compliance discussed?
	2. Does the protocol include clear and detailed information on taking measurements with example survey forms included? (Protocol variables and measurements may be discussed in detail in a SOP. A complete set of forms should be included in either the supplementary materials or a SOP.)
	3. Is the method of access for sampling sites provided?
	4. Is there an overview of procedures for establishing, monumenting, and maintenance of plots discussed in one or more SOPs?
	5. Does the protocol include details for the post-collection processing of samples or vouchers?
	6. Does the protocol include procedures to be followed at the end of the field season?
Section 5	D. Data Handling, Analysis and Reporting (Chapter 4)

	1. Does the protocol provide an overview of the process for entering, editing, and storing data, identification of database software, and whether the database is consistent with the recommended I&M database template structure? (For water quality protocols, see specific water quality guidance in Part B or WRD's General Comments 15, and checklist items in Section 2, items 8-10, below.)
	2. Are quality assurance (QA) and quality control (QC) procedures presented for the various levels of data collection and analysis? (See water quality Part B guidance or General Comments 15 as appropriate.)
	3. Is the data structure clearly presented and sufficient to capture the required information to meet the stated goal? Is there an overview of the database design?
	4. Are there recommendations for routine data summaries and statistical analysis to detect change?
	5. Is there a recommended reporting schedule?
	6. Is there a recommended report format with examples of summary tables and figures?
	7. Is there a recommendation for long-term trend analysis (*e.g.*, every 5 or 10 years)?
	8. Does the protocol narrative include an adequate description of metadata and data archival procedures?
	9. Does the protocol narrative describe the frequency of testing and review of protocol effectiveness?
Section 6	E. Personnel Requirements and Training (Chapter 5)
	1. Does the narrative include a listing of the personnel and describe their roles and responsibilities, and qualifications?
	2. Does the protocol include a discussion of training procedures for personnel?
Section 7	F. Operational Requirements (Chapter 6)
	1. Are facility, vehicle and equipment needs identified?
	2. Is there a summary of key partnerships with agencies, organizations and individuals that are part of the monitoring program and a description of their contribution? Is there a list of relevant cooperative agreements and other partnership agreements, if applicable?
	3. Is a schedule for the annual fieldwork and administrative needs required to implement this protocol included?
	4. Is there an overall budget that summarizes the annual and periodic costs of implementation of the protocol? Does it seem reasonable?
	5. Does the staffing plan and budget demonstrate that adequate resources have been allocated to data management, analysis, and reporting activities (ca. 30% are recommended)?

Section 8	G. Literature Cited (Chapter 7)
	1. Are the literature citations relevant, sufficient and consistently formatted?
Section 9	Standard Operating Procedures (Selected essential SOPs in addition to those mentioned in the narrative outline are identified in the checklist below. For Water Quality protocols, Part B Guidance or WRD's General Comments 15 should be consulted when developing SOPs.)
	1. Is there a table of contents for the SOPs?
	2. Are changes to each SOP clearly identified with a title, version number or revision date, and page numbers? Changes to protocol modules (Chapters or SOPs) should be reflected in the overall protocol version number and protocol revision history log either through a minor or major revision; however, you may also wish to develop a numbering scheme for SOPs, *e.g.*, SOP 1.00, 1.01…
	3. Is there a SOP with instructions for revising the protocol and a revision history log?
	4. Is there a SOP with instructions for preparation before the field season? Is there a SOP with instructions for procedures and equipment storage during and after the field season? (Also see numbers 10 and 11.)
	5. Is there a SOP for training field personnel?
	6. Is there a SOP that clearly defines protocol variables and how to measure them? (See Checklist, Section 1C2.)
	7. Are there clear and detailed driving and other navigational instructions to sampling sites?
	8. Are the details of Data Management identified in one or more SOPs? Topics to be included are at minimum identified in Section 1D and may include customized data management routines. Specifically for water quality monitoring data, does the SOP specify how data will be reported to WRD for entry into the Environmental Protection Agency's STORET database?
N/A	9. For water quality monitoring and other monitoring as appropriate, is there a quality control SOP associated with each protocol that adequately documents QC objectives for measurement sensitivity (detection limits), measurement precision, measurement systematic error (bias as percent recovery), data completeness (including adequacy of planned sample sizes and statistical power – this topic may be in the SOP on Sampling Design), and (if applicable for lab measurements only) blank control? Are instrument calibration details included either in the QC SOP or in a separate calibration SOP?
N/A	10. For water quality protocols, is there a SOP that includes an explanation of how data comparability (a quality assurance basic) was considered in choosing which protocols and chemical labs to utilize? Do protocol SOPs contain enough field and lab method details to allow others to determine if data produced is comparable enough to other regional data sets to be considered credible by regulatory agencies interested in the data?

N/A	11. Do aquatic protocol SOPs adequately describe the details of all Sampling Protocols (Field and Laboratory), as well as equipment needs and operation, sampling techniques, sample preservation and handling and logistics?
	12. Are all major procedures required for the protocol sufficiently explained? Are any SOPs missing?
	13. Are the literature citations with the SOP relevant, sufficient and consistently formatted?
Section 10	Supplementary Materials or Appendices
	1. Is there a table of contents with Section 3 – Supplementary Materials that clearly identifies the materials provided in this section of the protocol?
	2. Are the supplementary materials relevant, sufficient and consistently presented? Consistent formatting is desirable, but not always possible.
	3. Are data collection forms provided either in this section or in an SOP?
	4. Is there a section for the Administrative Record that provides the history of protocol development and refinement? (The published protocol may be presented either in Section 2 or Section 3 depending upon its contribution to the current protocol.)

Appendix SOP 1 B. PWR Protocol Review Checklist.

UNIVERSITY OF WASHINGTON

School of Forest Resources Box 352100
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James K. Agee, Emeritus Professor of Forest Ecology
112 Winkenwerder Hall

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January 4, 2010

The review of the San Francisco Bay Area Network Protocol for **Monitoring Riparian Habitat and Associated Wetlands, Pinnacles National Monument** has been completed. The protocol decision is

ACCEPTABLE WITH SUBSTANTIAL REVISION

Attached to this letter are review and informational documents: (1) a PWR Protocol Review Checklist. Each question is addressed in the left column; if scientific, it is addressed by me and the word is in bold, and if administrative is addressed in normal font, as a “yes”, “no”, “in part”, or N.A. [not applicable]. Extended administrative review comments follow the checklist. (2) The individual reviews are included with author’s names erased, and reviewers are identified as R1 or R2; my comments, including a few clarifications to R1 and R2 comments, are identified as PRC. The reviews are self-explanatory, but what I attempt to do here is place them in an integrated context beyond the abbreviated response in the PWR Protocol Review Checklist.

Major issues identified by reviewers include (*italics are responses by author Marie Denn*):

- Thresholds that will trigger management action are required (R2, PRC) *Comment 13:* ***edited*** *text in protocol section 1.6 to reflect literature review and discussions between network staff and park managers regarding appropriate thresholds and triggers for management.*

- Reporting frequency is confusing. Is there a need for weekly reports (R1)? *Comment 90: weekly data entry and updating to the Principal Investigator / Project Coordinator is ideal so that observers can more-easily correct (and not repeat) data collection errors, rather than completing data entry at longer intervals. It is also ideal for observers to send data to the project manager frequently - for data quality checks and also to inform managers of weed- and wildlife-watch species as soon as possible for follow-up management action. Comment 93: these are not weekly “reports”. As described in section 4.6 these are very informal weekly updates, which are for the purpose of good communication between the field crew and the (potentially offsite) Principal Investigator / Project Coordinator during the 10-week field season. As described in section 4.6 the weekly updates would consist of raw data, very rudimentary summary of the locations visited and weed- and wildlife-watch species observed only.* Annual reports appear to be defined as once every three years, which is not annual. ***Edited*** *protocol to change “Annual report” to “End of year report” throughout*. Then there are tables with a 2-yr reporting frequency, and no definite period for trend analysis. *I have scoured the document multiple times, and also searched the document under "two" and "2" and cannot find a table that specifies a 2-year reporting frequency. The protocol should not refer to a 2-year reporting frequency because the protocol is only implemented every third year.* ***Edited*** *text to define when trend analysis should be conducted – after every third data collection year (i.e., once every 9 years). There is no defined period when this protocol would end; trend analysis would continue until this protocol is ended due to lack of funding and/or changed network priorities.*

- Procedures for trend analysis are insufficient and the power analysis is confusing (R1, PRC). *Comment 47: abundance of wetlands (Objective 1) – as binary data - would be analyzed for trends with logistic regression. These are frequency data (i.e., for all the 25-meter segments in the sample frame how many of them have wetlands vs. how many do not) so logistic regression is an appropriate tool for multi-year trend analyses. Edited table to attempt to clarify. Abundance of channels is not a metric being tracked by this protocol. Please see the (new) Appendix B for linear and logistic analyses of simulated data. Comment 43: removed power analyses. Because transect data for Objectives 2 and 3 are based on permanently placed sample units, of course the individual transects will be compared against themselves over time and the metrics for variability used by statistical analyses are based on the aggregation of the differences of each sample between year 1, year 2, etc. (i.e., did all the sample values increase in year 2? Or decrease? Or is there high variability in these changes that indicates no overall change?). Therefore, the only way to estimate the power of this design to detect change is to assume a stated correlation between the first year and subsequent years (see Elzinga et al. 1998 and also Zar, J.E. 2009. Biostatistical Analysis, Fifth Edition. Prentice Hall, Saddle River, NJ. 960 pp). Agree that without this assumption an estimate of the power of the design cannot be conducted, so the analysis has been removed and will wait for analysis based on the first two full implementation years - as a post-hoc power analysis. No power analysis is needed for Objective 1 as it represents a full census of the target population.*

- Which system of wetland identification is actually being used: a 1, 2, or 3 parameter method? (R1) *Comment 71: this protocol does not advocate a one parameter method (i.e., mapping all areas as wetlands that exhibit one wetland parameter). The NPS wetland standard is to identify all areas as wetlands that fit the Cowardin definition - whether or not they have all three Army Corps parameters needed for jurisdictional wetlands - recognizing that identification of ecologically functioning wetlands are more complex than the simple but legally-defensible clear and robust definition used for defending wetlands from development. Comment 72: For the purposes of identifying wetlands for this monitoring program, hydrology and vegetation alone (without hydric soils) can identify a wetland IF the system is described by Cowardin et al. Most stream beds do not have wetland soils but many fit the Cowardin definition of "riverine" (or "palustrine" for small fluvial systems) wetlands. Comment 53:* ***Edited*** *text under section 2.2.1.3 and SOP 5 to improve the description of how to identify a "wetland."*

- Some attention to figure quality is needed (A, PRC, R1) *Comment 66: I recreated the maps from the ground up to attempt to improve the color schemes and line weights to address this concern, and increased the sizes of the other images.*

- A better defense for collection of ancillary data is needed (R2) *Comment 94: removed 4 ancillary data collection items: Non-native annual grass abundance, depth of deepest pool, anthropogenic disturbance, and photodocumentation due to concerns about relevancy of these data and investment needed to collect, store, analyze, and interpret the data. The other ancillary data are rapidly collected and will be valuable for interpreting landscape change at Pinnacles NM.*

- ***Vegetation Community:*** *Data collection is extremely rapid – observers will choose the appropriate community from the monument's vegetation key. These data will show changes in vegetation communities over time and help with interpretation of quantitative transect data collected by this protocol.*
- ***Non-native Annual Grass Abundance:*** *removed.*
- ***Plant Layers and Dominant Plants:*** *Data collection is extremely rapid, will assist with interpretation in changes in the quantitative transect data collected by this protocol, and also necessary for using the CRAM metric "vertical biotic structure"*
- ***Weed and Wildlife Watch Species****: These data are highly useful for management purposes as park staff are actively controlling these species. They will cost staff time only for the following: observers learning to identify the watch-list species at the beginning of the field season, observers recording any watch list species incidentally observed. Data will be anecdotal as observers will not be systematically or consistently searching for these species.*
- ***UTM Coordinates and Elevation:*** *These data are collected for the purpose of mapping data for presentation and use with GIS systems.*
- ***Rosgen Channel Type and Number of Bankfull Channels:*** *The reviewer suggested that instead of Rosgen channel type, observers measure multiple channel morphology parameters (e.g., channel width, channel depth, floodprone area width). This monitoring protocol does measure channel width (i.e., bankfull width) at each transect, but field testing found that measuring other channel characteristics was too time consuming and would not be repeatable without permanent markers in the field (these were infeasible due to park management concerns, channel evolution, and time required to re-find markers). Rosgen channel typing is a rapid assessment of the relative stability and potential trajectory of channels, and is well-tested, rapid, and repeatable. These data will illuminate landscape evolution and help with interpretation of the quantitative data from the transects.*
- ***Depth of Deepest Pool/Run of Standing Water at Reachpoint Cross-section:*** *removed.*
- ***No or Limited Data Collected due to Hazardous Conditions:*** *The purpose of recording this information is not to show change over time, and there is likely substantial variation between observers regarding whether or not a reach or transect is safe enough for data collection. Other vegetation data gathered as part of this protocol are much better signals of change of vegetation density and surface water abundance.*
- ***CRAM-derived Metrics:*** *These metrics are collected to quickly and repeatably (Clark et al. 2006) capture observers' judgment of the condition of the reach. These will be converted into a GIS layer, based on stream reach UTM, to provide managers with overall single-visit assessments of the condition of stream reaches in the monument. Although CRAM metric data are categorical - not quantitative - and cannot be evaluated with parametric statistics, the percent frequency of values for individual metrics (e.g., how many reaches in Frog Canyon scored "A" for "buffer condition") can be tracked over time by reach in a stream to evaluate gross changes in condition over time.*
- ***Anthropogenic disturbance:*** *removed.*

- ***Photodocumentation:*** *Collection of these data requires little time in the field but require considerable effort for data storage. Removed).*

- Why were groundwater-dependent wetlands excluded, and are different kinds of wetlands being lumped together that may obscure detection of change? (R2) *Comment 95: The San Francisco Bay Area Network ranked "wetlands" as the 11th most important vital sign, and described a desire to track changes in abundance of wetland habitat at the landscape scale for Pinnacles NM, Point Reyes NS, and Golden Gate NRA. This Pinnacles monitoring protocol was developed in response to that prioritization. At Pinnacles NM virtually all of the springs are not wetlands – generally these are represented by small areas where water emerges from rock with no soil development and few plants. Other springs are represented by damp soil under heavy evergreen canopy without preponderance of wetland plants or, upon investigation, hydric soils. These systems may be ecologically important to the overall landscape by contributing water through the groundwater table to the riparian system through the summer, but they are not local hotspots of biodiversity. There are two groundwater-driven systems in the park that are clearly old, developed (i.e., with hyrdic soils and a dense canopy of wetland plants) wetland "springs" – McCabe Spring and Willow Spring. These two very-different systems (one dominated by a dense willow thicket, the other by Juncus and Muhlenbergia species) surrounds and heavily influences the flora of a portion of the adjacent creek system (McCabe Spring sits on and adjacent to McCabe Creek, Willow Spring sits on and adjacent to Upper Chalone Creek). This monitoring protocol will detect changes in the flora and geomorphology of the creeks adjacent to these groundwater-driven systems as a part of its landscape-scale monitoring. At the beginning of the design process for this protocol the network and the park staff evaluated whether to monitor all in-channel wetlands and the riparian zone throughout the park (what we eventually did) – or whether to design two protocols to track changes at these two specific spring wetlands. All staff agreed that monitoring these two small sites is a park-level task and recommended moving forward with designing a landscape-scale protocol for in-channel wetlands and riparian systems. The park is proceeding with developing a monitoring protocol to meet their specific management concerns at McCabe Spring. Comment 97: there is some debate among federal (NPS, USFWS, FS) personnel and protocols with respect to whether small, ephemeral streams – such as those at PINN – should be classified in the Cowardin Riverine or Palustrine system. It's a bit of a semantics issue for this protocol because PINN has no large rivers, so different kinds of wetlands – as in some Riverine and some Palustrine – would not be lumped together. The USFWS National Wetlands Inventory – the main user and developer of the Cowardin system – reserves the "Riverine" system for large, permanent rivers and classifies smaller, ephemeral streams as Palustrine. This is supported somewhat (although not clearly) in the 1979 Classification. This PINN protocol follows that convention, so there are no "Riverine" wetlands at PINN (as stated in SOP 5). Also there are no isolated streamside (i.e., floodplain) wetlands at PINN. Some wetlands may never migrate because they are fed by deep, permanent aquifers and this protocol will eventually differentiate those wetlands that are stable in the landscape from those that are expressions of the surface and near-surface stream flows (this is described briefly in section 2.1.2). It is not possible to distinguish at this time whether an instream wetland is fed from this year's rainfall or is fed by a permanent deep aquifer. However – based on discussions with park staff that have observed changes in the stream system after several large flow events, we assume that "permanent" in-stream wetlands fed by deep groundwater are very rare. It is possible that the "ephemeral" instream wetlands would increase in abundance (possibly due to* *climate change) just enough to offset a decline in the abundance of "permanent" wetlands (possibly due to distant groundwater withdrawal), and therefore the protocol would yield an erroneous "no change" conclusion. However, there is no way at this time to avoid this problem, as we cannot distinguish these populations at this point. It is true of any monitoring protocol that unknowable variation in the target population may swamp fine-scale results (e.g., genetically disadvantaged birds may have higher mortality, but their mortality may be offset by better survival of their cousins. A monitoring protocol merely tracking bird abundance may miss the different trends in these two sub-populations of birds. It may not matter to the monitoring protocol if it merely wishes to track overall bird abundance. For this protocol, we wish to track overall in-stream wetland abundance).*

- A data dictionary is required for approval (PRC) *(Data dictionary **completed** and documentation inserted in SOP 4)*

This protocol may not require further outside review if an adequate response is made to reviewer comments. When resubmitted, we'll evaluate the response to reviewer comments in-house. In order to facilitate this next review, please provide a detailed list of how you addressed <u>each</u> review comment. I look forward to receiving your response.

Sincerely,

James K. Agee
PWR Protocol Review Coordinator

Attachment: Protocol Reviews

PWR PROTOCOL REVIEW CHECKLIST

Protocol Name: PINN Riparian Habitat and Associated Wetlands

Science Reviewer: J.K. Agee Admin. Reviewer: Joel Siderius 12/31/2009

Science issues in bold, administrative issues in regular font

Red Text=extended administrative comments.

	Overall Organization and Presentation of Protocol Narrative
YES	1. Is the overall monitoring protocol well-organized with sections clearly delineated?
In-Part	2. Does the protocol have a title page with authors' names, protocol version number and date? (Protocol version numbers should be constructed to allow for both major and minor changes). Is there a Table of Contents, abstract, and the three basic sections: 1-Narrative, 2-Standard Operating Procedures (SOPs), and 3-Supplementary Materials or Appendices recommended in the NPS standards published by Oakley et al. 2003 (http://science.nature.nps.gov/im/monitor/protocols/ProtocolGuidelines.pdf).
YES	3. Is there a complete and accurate table of contents with page numbers? (Chapters should be paginated consecutively, i.e. Chap. 1 (pp. 1-20), Chap. 2 (pp. 21-28), Chap. 3 (pp. 29-44), etc. to allow for modular updates.)
	4. Are the tables and figures clearly labeled and understandable?
Yes	5. Is the protocol bound so that it lies flat, preferably in a 3-ring binder?
Section 1	**A. Background and Objectives (Chapter 1)**
Yes	1. Does the protocol narrative provide a rationale or justification for why a particular resource or resource issue was selected for monitoring? Is the history and background for this resource issue well-referenced with supporting literature cited?
Yes	2. Does the protocol narrative discuss the linkages between this and other monitoring projects?
Yes	3. Does the protocol narrative describe how monitoring results will inform management decisions?
Mostly	4. Does the protocol narrative contain careful documentation of the monitoring objectives or monitoring questions being asked?
No	5. Does the protocol narrative identify specific measurable objectives such as thresholds or trigger points for management actions?
Section 1	**B. Sampling Design (Chapter 2)**
Yes, but see R2	1. Is there a clear and logical rationale for selecting the sampling design over others?
Yes	2a. Were the criteria for site selection clearly discussed including stratification, spatial design, and whether this monitoring will be co-located and/or integrated with other VS monitoring protocols? (See Checklist, Section 1A2.)
Yes	2b. Has the target population or "sampling frame", and the sampling units, been identified? In other words, is the desired level of inference clear?
Yes	3. Is the sampling frequency and replication identified?
Yes	4. Is the timing of sampling defined?
No	5. Are the location of sampling sites clearly identified?
Needs clarification	6. Is the level of change that can be detected for the amount or type of sampling being instituted identified? (See Checklist, Section 1A5.)
Section 1	**C. Field Methods (Chapter 3)**
Yes	1. Are preparations for the field season and equipment setup included? Are requirements for permitting and compliance discussed?
Yes	2. Does the protocol include clear and detailed information on taking measurements with example survey forms included? (Protocol variables and measurements may be discussed

	in detail in a SOP. A complete set of forms should be included in either the supplementary materials or a SOP.)
Not clearly	3. Is the method of access for sampling sites provided?
Y	4. Is there an overview of procedures for establishing, monumenting, and maintenance of plots discussed in one or more SOPs?
N.A.	5. Does the protocol include details for the post-collection processing of samples or vouchers?
Yes	6. Does the protocol include procedures to be followed at the end of the field season?
Section 1	**D. Data Handling, Analysis and Reporting (Chapter 4)**
Yes	1. Does the protocol provide an *overview* of the process for entering, editing, and storing data, identification of database software, and whether the database is consistent with the recommended I&M database template structure? (For water quality protocols, see specific water quality guidance in Part B or WRD's General Comments 15, and checklist items in Section 2, items 8-10.)
Yes	2. Are quality assurance (QA) and quality control (QC) procedures presented for the various levels of data collection and analysis? (See water quality Part B guidance or General Comments 15 as appropriate.)
Yes	3. Is the data structure clearly presented and sufficient to capture the required information to meet the stated goal? Is there an overview of the database design?
Not clearly	4. Are there recommendations for routine data summaries and statistical analysis to detect change?
Yes	5. Is there a recommended reporting schedule?
In-Part	6. Is there a recommended report format with examples of summary tables and figures?
Not clear	7. Is there a recommendation for long-term trend analysis (e.g. every 5 or 10 years)?
Yes	8. Does the protocol narrative include an adequate description of metadata and data archival procedures?
Yes	9. Does the protocol narrative describe the frequency of testing and review of protocol effectiveness?
Section 1	**E. Personnel Requirements and Training (Chapter 5)**
Yes	1. Does the narrative include a listing of the personnel and describe their roles and responsibilities, and qualifications?
Yes	2. Does the protocol include a discussion of training procedures for personnel?
Section 1	**F. Operational Requirements (Chapter 6)**
Yes	1. Are facility, vehicle and equipment needs identified?
In-Part	2. Is there a summary of key partnerships with agencies, organizations and individuals that are part of the monitoring program and a description of their contribution? Is there a list of relevant cooperative agreements and other partnership agreements, if applicable?
Yes	3. Is a schedule for the annual fieldwork and administrative needs required to implement this protocol included?
Yes	4. Is there an overall budget that summarizes the annual and periodic costs of implementation of the protocol? Does it seem reasonable?
Yes	5. Does the staffing plan and budget demonstrate that adequate resources have been allocated to data management, analysis, and reporting activities (ca. 30% are recommended)?
Section 1	**G. Literature Cited (Chapter 7)**
Yes	1. Are the literature citations relevant, sufficient and consistently formatted?
Section 2	**Standard Operating Procedures (Selected essential SOPs in addition to those mentioned in the narrative outline are identified in the checklist below. For Water**

	Quality protocols, Part B Guidance or WRD's General Comments 15 should be consulted when developing SOPs.)
YES	1. Is there a table of contents for the SOPs?
YES	2. Are changes to each SOP clearly identified with a title, version number **or** revision date, and page numbers? Changes to protocol modules (Chapters or SOPs) should be reflected in the overall protocol version number and protocol revision history log either through a minor or major revision; however, you may also wish to develop a numbering scheme for SOPs, e.g. SOP 1.00, 1.01…
Yes	3. Is there a SOP with instructions for revising the protocol and a revision history log?
In-Part	4. Is there a SOP with instructions for preparation before the field season? Is there a SOP with instructions for procedures and equipment storage during and after the field season? (Also see numbers 10 and 11.)
Yes	5. Is there a SOP for training field personnel?
Yes	6. Is there a SOP that clearly defines protocol variables and how to measure them? (See Checklist, Section 1C2.)
No	7. Are there clear and detailed driving and other navigational instructions to sampling sites?
Yes	8. Are the details of Data Management identified in one or more SOPs? Topics to be included are at minimum identified in Section 1D and may include customized data management routines. Specifically for water quality monitoring data, does the SOP specify how data will be reported to WRD for entry into the Environmental Protection Agency's STORET database?
N.A.	9. For water quality monitoring and other monitoring as appropriate, is there a quality control SOP associated with each protocol that adequately documents QC objectives for measurement sensitivity (detection limits), measurement precision, measurement systematic error (bias as percent recovery), data completeness (including adequacy of planned sample sizes and statistical power – this topic may be in the SOP on Sampling Design), and (if applicable for lab measurements only) blank control? Are instrument calibration details included either in the QC SOP or in a separate calibration SOP?
N.A.	10. For water quality protocols, is there a SOP that includes an explanation of how data comparability (a quality assurance basic) was considered in choosing which protocols and chemical labs to utilize? Do protocol SOPs contain enough field and lab method details to allow others to determine if data produced is comparable enough to other regional data sets to be considered credible by regulatory agencies interested in the data?
N.A.	11. Do aquatic protocol SOPs adequately describe the details of all Sampling Protocols (Field and Laboratory), as well as equipment needs and operation, sampling techniques, sample preservation and handling and logistics?
Yes/No	12. Are all major procedures required for the protocol sufficiently explained? Are any SOPs missing?
Yes	13. Are the literature citations with the SOP relevant, sufficient and consistently formatted?
Section 3	**Supplementary Materials or Appendices**
N.A.	1. Is there a table of contents with Section 3 – Supplementary Materials that clearly identifies the materials provided in this section of the protocol?
N.A.	2. Are the supplementary materials relevant, sufficient and consistently presented? Consistent formatting is desirable, but not always possible.
N.A.	3. Are data collection forms provided either in this section or in an SOP?
N.A.	4. Is there a section for the Administrative Record that provides the history of protocol development and refinement? A summary event table is highly recommended in addition to the supporting materials required in the Protocol Review File Checklist, e.g. the initial study plan or protocol development summary, the results of protocol development studies,

	peer review comments and responses during the development phase, and/or any published protocol on which a major portion of the methodology included in this protocol is based. (The published protocol may be presented either in Section 2 or Section 3 depending upon its contribution to the current protocol.)

Extended Administrative Review Comments
Joel Siderius, 12/31/2009

General/Editorial Comments

Great care has clearly been taken to meet the administrative requirements. This effort shines through, with only the few exceptions noted below. Overall, great job.

I love the images in SOP #3. Figure SOP 3.1, 3.2, and 3.3 they add significantly to the presentation.

However there are 2 figures SOP 3.2 in the text, though not in Figures List in SOP-3 *(Comment 1: **edited** caption)*

Overall Organization and Presentation of Protocol Narrative

2. The title page(s) are lacking the Version # of this document. *(Comment 2: **edited** title pages)*

3. There are some pagination issues. (*Comment 3: document editor addressed problem*)

Page 50 is missing *(Comment 4: document editor addressed problem)* and Chapter 4 starts on the left facing page. *(Comment 5: document editor addressed problem)*

Page 62 is missing *(Comment 6: document editor addressed problem)* and Chapter 6 starts on a left facing page. *(Comment 7: document editor addressed problem)*

SECTION 1.A Background and Objective

No extended comments

SECTION 1.C Field Methods

No extended comments

SECTION 1.D Data Handling

6. Section 4.6 is excellent. However, no examples of figures or tables are mentioned or shown. *(Comment 8: **edited** section 4.6 to refer to the Sample Summary Table in Appendix A (Appendix A is the presentation of pilot data)*

<u>SECTION 1.F Operation Requirements</u>

2. Section 6.2 does not tell us anything new. From reading this section it appears that there actually are NOT any partnerships, no collaborations with local scientists, local stakeholders who might be interested in the Project, local government, the State Fish and Wildlife agency etc. I find Section 6.2 to be somewhat misleading, if fact no partnerships are relevant it does not seem like this Vital Sign is particularly relevant. *(Comment 9: Yes, this monitoring project has no partnerships with non-NPS entities. The NPS undertakes many monitoring projects without reference to universities or other governments in order to manage NPS lands. The project is essentially to walk the creeks of a small monument every third year and collect a modest amount of information – the NPS does this type of data collection routinely without any interest from outside entities. The data are relevant to NPS natural resource managers at Pinnacles National Monument despite the lack of academic or state government partnerships.)*

5. It is impossible to tease out if 30% of this budget goes to Data Management. It is mentioned in the text but that appears to be inserted mainly to appease reviewers. *(Comment 10: **Edited** section 6.4 to better estimate the effort that will go toward data management)*

<u>SECTION 2</u>

4. Between Chapter 3 and SOP #3 all the info is presented.

7. Appendix A appears to mention 6.9% of wetland monitoring sites and Section 2.2.1, and Figure 2.1. attempt to elucidate sampling sites. However, as presented, it is rather nonsensical as to how to get to known sites. *(Comment 11: At present there are no known sampling sites. Data collection procedures changed enough between pilot data collection and the final protocol that the 2009 data will not be used in the long-term trend analyses. **Edited** introduction to Appendix A to clarify. Finding sites each year is described in section 3.4.)*

I recognize that having a map or giving driving directions to all 466 potential sites is unrealistic. However, a map with roads and key trailheads may be helpful. *(Comment 12: Figure 1.2 provides a map showing the two roads in the park. The equipment list in SOP 3 requires observers to have specific, detailed maps of the park which include all trailhead names and parking lots from which observers will be accessing the creek system.)*

PRC Review

Introductory comments:

- The thresholds and trigger points for management need to be defined better. ***(****Comment 13: edited text in protocol section 1.6 to reflect literature review, and discussions between network staff and park managers regarding appropriate thresholds and triggers for management.)*
I just didn't buy the idea that quantitative points can't be defined – and by doing so, you make them "appropriate". The protocol can't be approved without this.

It seems that pacing to establish the 100-m intervals is just too inaccurate to meet the monitoring objectives. If there is a 5% error in the same direction (acceptable according to this protocol, p 37) every 20 transects there is complete overlap with a previous 100 m interval – this means that some areas might never get measured and other will be measured twice. *(Comment 14: Transects will be permanently placed and re-positioned in the same location each data collection year (see Section 3.2) at approximately 300-meter intervals along the channel (with some randomization to avoid severely restricting the possible number of samples, see Section 3.2 paragraph 6.) These will be relocated by field observers with GPS (see Section 3.4.) Between transects observers will pace the reaches in 100-meter intervals. The purpose of the 100-meter reaches along the stream is to estimate the percent frequency of wetlands in the entire stream channel while allowing for PINN's highly mobile channel structure (see Section 2.2.) Permanently marking the ends of every 100-meter reach would not accommodate rapid channel evolution - in time, some of the original segments would be much greater than 100-meters, and some would shorten to less than 100-meters. The upper-end point of each stream channel is permanently marked with a GPS coordinate, so the sample frame will not change due to variability in pacing.)* If GPS waypoints were established on the first year of sampling (a GPS unit is required every year for the cross-section transects) then the 100 m points could be pretty well established and without the progressive error that pacing usually results in. The 25-m lines could then be estimated pretty closely and after 3 years you are confident in having a complete survey.

A complete data dictionary is required in order for protocol approval. *(Comment 15: data dictionary **completed** and documentation inserted in SOP 4)*

Specific Comments (by page, paragraph, and line number as needed):

Vii: 6.3.2.1: fix "error" *(Comment 16: **edited** text)*
Xiii: There are no national parks in this network: "…Network of the National Park System…" *(Comment 17: **edited** text)*
P1, par.2: Monitoring objective 1 uses the word "abundance", which is rather fuzzy *(Comment 18: To be more specific about the exact measure also requires more specificity about the survey frame. The alternative text would be: "Determine the percent frequency of wetlands within 25-meter-long segments within the bankfull banks of stream channels at Pinnacles National Monument" which actually makes the objective less clear in my opinion. I did not change as I prefer the more-general "abundance" here, with details of what "abundance" means in later protocol text.)*
P1, par. 2: foliar cover by herbaceous guild? After all, shrubs and trees are guilds, too. *(Comment 19: **edited** text to attempt to clarify – the objective is to track cover for several general guilds, then cover for each tree and shrub species observed. Please assist with suggestions for more-clear text if this is still unacceptable.)*
P2, 1.2.2: riparian habitat is not discussed in this section, should be cut from the title. *(Comment 20: **edited** text)*
P2, last par. Environmental Research 1987 is Environmental Laboratories 1987 in lit cit. *(Comment 21: **edited** text both here and in citation to Environmental Laboratory)*
P3, par 1 and 2. Same issue as p2, last par. *(Comment 22: **edited** text)*
P3, last par. L3: Cowardin et al. 1979 *(Comment 23: **edited** text)*

P4, par 4, and p5, par 5: Gosslink is Gosselink in lit cited. *(Comment 24: **edited** text)*
P6, second to last line: Saywer is Sawyer in lit cited. *(Comment 25: **edited** text)*
P9, Table 1.1. Where in the monument is the station located? *(Comment 26: **edited** text)*
P10,11: figures 1.2, 1.3 have "Executive" spelled wrong within the map legend (*Comment 27: **edited** figure)*
P11, Figure 1.3: Watersheds are more than just the color green. Revise legend to indicate watersheds are various colors. *(Comment 28: **edited** figure)*
P11, l 3 from bottom: please define a "major" watershed. *(Comment 29: **edited** text)*
P13, par.2: Q. wislizenii? P, balsamifera ssp. Trichocarpa (*Comment 30: **edited** text)*
P16, l2: Gerdali is Gardali in lit cit *(Comment 31: **edited** text)*
P16, last paragraph – see PRC introductory comments *(Comment 32: see reply to Comment 13)*
P20, par 3. "One-third of these reaches will be evaluated each year…" *(Comment 33: **edited** text)*
P20, figure 2.1 – see comment on p. 10. *(Comment 34: **edited** figure)*
P20, par 2, l2: Table X is 2.1 *(Comment 35: **edited** text)*
P21, last 2 lines: Ten of the 12 streams have less than 1/3 of their segments with transects. There needs to be a bit more detail about how the extra transects will be chosen and located. *(Comment 36: **edited** text to clarify)*
P22, par 1, last line: "…able to complete annual data collection…" *(Comment 37: **edited** text)*
P23, par 2: Pacing will not be adequate to define 100 m segments (see PRC Introductory comments *(Comment 38: see reply to Comment 14)*
P23, par 4: Make it clear early on in this paragraph that these are permanent transects that will be remeasured each year. Reading this I was confused, although it is mentioned in the next paragraph. Why not title section 2.2.1.3 "Permanent Annual Transects at 300-m intervals"? *(Comment 39: **edited** text)*
P25, Figure 2.3. Frequency is simply a number. I think you are referring to relative frequency, which is a percent. For the example shown, frequency is 3, relative frequency is 75%. *(Comment 40: actually, referring to percent frequency. **Edited** text throughout.)*
P31, par.3, l1: "..addressed by comparing the relative frequency…" *(Comment 41: see reply to Comment 40)*
P31, last par. The midpoints are incorrect: class 2 is 17.5, and class 3 is 37.5. *(Comment 42: **edited** text)*
P32. The power analysis is not clearly defined. It seems that it rests almost entirely on an assumption of high correlation between years, but PINN has no such data, which makes the power analysis meaningless. *(Comment 43: removed power analyses. Because transect data for Objectives 2 and 3 are based on permanently placed sample units, of course the individual transects will be compared against themselves over time and the metrics for variability used by statistical analyses are based on the aggregation of the differences of each sample between year 1, year 2, etc. (i.e., did all the sample values increase in year 2? Or decrease? Or is there high variability in these changes that indicates no overall change?) . Therefore, the only way to estimate the power of this design to detect change is to assume a stated correlation between the first year and subsequent years (see Elzinga et al. 1998 and also Zar, J.E. 2009. Biostatistical Analysis, Fifth Edition. Prentice Hall, Saddle River, NJ. 960 pp.) Agree that without this assumption an estimate of the power of the design cannot be conducted, so the analysis has been removed and will wait for analysis based on the first two full implementation years - as a post-*

hoc power analysis. No power analysis is needed for Objective 1 as it represents a full census of the target population.)
P32, last par. Table X is 2.4 *(Comment 44: **edited** text)*
P33, par 1. *Erigonium fasciculatum* is an unknown species. *(Comment 45: **edited** text)*
P43, l1: It's a GRS densitometer – GRTS is an acronym for a spatially balanced sampling design. *(Comment 46: **edited** text)*
P55, Table 4.3. The logistic regressions proposed are seemingly applied to datasets with other than just 0 and 1 as outcomes (Abundance of wetlands, Abundance of channels.) Please provide a specific example of how this would be done. Also it would be best to described what you are really measuring (it is not abundance) – presence or absence? I think you need to provide a specific example of how both the linear regression and logistic regression would be applied – do it with simulated data if needed. (Comment 47: abundance of wetlands (Objective 1) – as binary data - would be analyzed for trends with logistic regression. These are frequency data (*i.e.,* for all the 25-meter segments in the sample frame how many of them have wetlands *vs.* how many do not) so logistic regression is an appropriate tool for multi-year trend analyses. Edited table to attempt to clarify. Abundance of channels is not a metric being tracked by this protocol. Please see the (new) Appendix B for linear and logistic analyses of simulated data.)
P55: The reporting schedule is not clear. An annual report is defined as once in three years, Table 4.3 shows a 2-year reporting schedule, and there is no specific long-term trend reporting period. *(Comment 48: **edited** text)*
Literature cited: pretty clean

Bunte and Abt: extra space right above this. *(Comment 49: **edited** text)*
Collins et al 2006. Fragment flips to next page *(Comment 50: **edited** text)*
Johnson and Starcevich. The only reason to cite people on unpublished material is so the reader can locate them and get it if needed. Please provide afflilations, location, etc. *(Comment 51: **edited** text)*
Parsons et al. "and" before C. Donovan. *(Comment 52: **edited** text)*

Reviewer #1 (R1)

This seems like a valuable set of concerns and a valuable protocol. I've outline my general and specific concerns on the protocol below. My biggest concern is with the specifics of determining areas of wetlands. *(Comment 53: I have removed any categorization of wetland size from the protocol due to this concern. Wetlands will be recorded as "present" or "not present" in each 100-meter reach only, with no size classification attempt. **Edited** text under section 2.2.1.3 and SOP 5 to improve the description of how to identify a "wetland.")*

General issues
I would like to see more specific detail on how wetland areas will be determined. As presented it seems pretty vague. *(Comment 54: for estimation of wetland size – i.e., how big each wetland is, please see reply to Comment 53. If this comment is more directed at how observers will identify wetlands – I **edited** SOP 5 to improve directions for identifying wetlands.)*
Early in the proposal, a range of different delineation methods are discussed (3 parameter Corps method, 1 parameter NPS method.) It appears that this protocol has adopted a 1-parameter method, but even this is not clearly presented (in the text or in the appendices.) *(Comment 55:*

see reply to Comment 71.) How will the border of wetlands vs. non-wetlands be determined. *(Comment 56: see reply to Comment 53.)* As presented, the method seems pretty general, and I could see some substantial difference in presence/absence of wetlands and particular in estimating area. (*Comment 57: see reply to Comment 53.)* I see additional information on this on p.23 under 2.2.1.2 -- but here it's identified that 2 parameters will be used: vegetation and hydrology. *(Comment 58: see reply to Comment 53.)* This all seems pretty confusing to me. And it also is not at all clear how wetland vs. non-wetland boundaries will be determined and area will be estimated on the fly. (*Comment 59: see reply to Comment 53),* Typical USACE delineations in the field are very time consuming. How accurate will these rapid estimates of area be, and how comparable are they between samplers? *(Comment 60: see reply to Comment 53.)* Similarly how might they vary in wet vs. dry years? *(Comment 61: whether or not a particular place will delinate or classify as a wetland is not generally influenced by a single wet or dry year – observers note more than one indicator to support the hypothesis that any one piece of ground is a "wetland" according to which ever definition is being used. For this protocol observers must find several indicators of wetland hydrology and a preponderance of wetland vegetation in order to characterize an area as a wetland. These – in general - do not reflect only one year's rainfall.)*

Secondarily, I wonder why such broad categories are used for some of the estimates (4 categories, 1-10%, 10-25%, 25-50%, 50-100%.) It seems like these very broad categories would substantially reduce the power of the monitoring to detect meaningful change. *(Comment 61: see reply to Comment 53)*

I found the presentation of the data collection design in Chapter 2 difficult to follow. Why start with rationale for rejecting other designs when the chosen design has not been identified? *(Comment 63: this information is a required subject, according to the protocol review checklist. This format was chosen to ensure that all of the required subjects were addressed, and to make it easy for reviewers to be able to find required subjects.)* Also, Section 2.1.2 doesn't seem to address what is presented in the heading? *(Comment 64: **edited** text.)* This whole introductory section of Ch. 2 seemed out of place and more confusing than helpful. I'd suggest directly and concisely identifying the design approach and then providing some brief justification unless there is some special reason for going into this detail here. *(Comment 65: see reply to comment 63.)* Section 2.2 also seemed difficult to follow (in part this is due to the poor quality of Figure 2.1.) *(Comment 66: I recreated the maps from the ground up to attempt to improve the color schemes and line weights to address this concern, and increased the sizes of the other images. The images do really print out fine on the printer at my office, and look fine to me as PDFs on several of our computer screens .)* I had to re-read this section a few times to finally understand the design. Better figures and a more direct statement of the layout in general would be useful -- then provide the specifics about the 47 kilometers, etc. *(Comment 67: **edited** text to clarif*y.)

Vegetation guilds are discussed throughout the protocol, but I didn't see any specifics/background information on what guilds will be used. *(Comment 68: see Section 2.2.2.2.)* Furthermore, how do these guilds compare to the other groups that are used in the protocol (e.g., vegetation layers from the CRAM method)? *(Comment 69: CRAM does not employ guilds, rather CRAM uses vegetation height. Managers at PINN wished vegetation information by guild rather than vegetation height.)* I also didn't see much in terms of how dominance will be determined for plant species. *(Comment 70: see Section 2.2.2.3 (under "Non-native annual grass abundance" and "Plant layers and dominant plants" and also SOP 5.)*

Specific points

p. 2 -- is this 1-parameter method widely used? *(Comment 71: this protocol does not advocate a one parameter method (i.e., mapping all areas as wetlands that exhibit one wetland parameter.) The NPS wetland standard is to identify all areas as wetlands that fit the Cowardin definition - whether or not they have all three Army Corps parameters needed for jurisdictional wetlands - recognizing that identification of ecologically functioning wetlands are more complex than the simple but legally-defensible clear and robust definition used for defending wetlands from development.)* Is hydrology alone enough to identify a wetland? *(Comment 72: For the purposes of identifying wetlands for this monitoring program hydrology and vegetation alone (without hydric soils) can identify a wetland IF the system is described by Cowardin et al. Most stream beds do not have wetland soils but many fit the Cowardin definition of "riverine" (or "palustrine" for small fluvial systems) wetlands.)* How would people differentiate an area with appropriate hydrology but that never supports wetland vegetation (au unvegetated sandy point bar) vs. one that might really be a wetland? *(Comment 73: For the purposes of identifying wetlands for this monitoring program please see SOP 5 of the protocol. The discussion in the Introduction of this protocol is not intended to be about tracking wetlands at PINN, but a general overview of wetland identification methods.)* I'm not familiar with the NPS 1-paraameter method, so I would expect more detail in the methods explaining how this is done. *(Comment 74: please see response to Comment 71 (re: "one parameter" method.) **Edited** SOP 5 for how observers will identify wetlands for tracking trends for this protocol.)*

p.3, para. 2: discussion of boundaries is not real clear. Focus this directly to the specifics of the protocol. *(Comment 75: this introductory section about wetland mapping is intended to generally describe the concept that identification of wetland "boundaries" is a human concept, and some of the problems of trying to identify wetland "boundaries" in any project; this section is not intended to be a methodology for this particular protocol. Please see SOP 5 for that discussion.)*

p.3-4, classification: HGM also seems like an important classification to identify, *(Comment 76: **edited** text)*

p.4, wetland function and classification: the distinction between condition and function is not clear to me. *(Comment 77: from page 4: "Wetlands functions are those ecosystem services that wetlands provide to support native biota and ecosystem resilence . . . Wetland condition can represent either ecological integrity or complexity or a conflation of both".)* Also, functions and values are different in most interpretations that I've seen. Functions apply broadly to all sorts of wetland dynamics and are separate/broader than wetland values. Values imply a human interpretation of functions and are a subset of the broader group of functions. *(Comment 78: **edited** text.)*

p. 5, para 3, 1st line -- isn't this a negative correlation between stressors and condition? *(Comment 79: **edited** text.)*

p. 6, 1.2.3.2 - it might be useful to use a diagram to illustrate the various components of the riparian system. *(Comment 80: there is a reference in this section for such a diagram "(see figure SOP 7.1)".*

p. 10, figure 1.2 (and almost all other figures, especially all maps): the figure quality in the version that I reviewed is so poor that most of the features in the figure were not distinguishable. *(Comment 81: please see reply to comment 66.)*

p. 13, para. 2, a figure here to illustrate where the various plant species are typically found might be useful - -are there predictable horizontal or vertical zonation/patterns in the dominant plants that are discussed in this paragraph? *(Comment 82: All of the plants discussed in this paragraph are typical of the riparian and floodplain zones. PINN does not exhibit notable elevational zonation in the riparian systems.)*

p. 14, para. 2: CRAM was developed from the Ohio rapid method. *(Comment 83: thanks for the catch! **edited** text.)*

p. 21, para 1. it might be useful to briefly and generally identify the parameters that will be measured across these three spatial scales. *(Comment 84: table **created** in section 2.2.)*

p. 22, last paragraph: may not be necessary to identify here, but somewhere you should identify how you will determine dominance for plants. *(Comment 85: **edited** text.)* Also, is it useful to measure the CRAM data on every 100 meter reach? If it's not real time consuming, I can see that it might as well be collected, but I would think that it is more likely to change on a broader scale. *(Comment 86: pilot data evaluated this very concern - data collected from the CRAM protocol change gradually as observers move up the channel collection every 100 meters better reflected the trends in the channel, also 100-meter reaches were fairly homogenous in most areas whereas 300-meter reaches often exhibited differences between one end and the other that made the CRAM metric data less reflective of conditions on the ground. Data collection is extremely rapid.)*

p. 27, para 2: what are the current species of interest for weeds and wildlife watch? - *(Comment 87: the paragraph references SOP 8 for species list.)*

p. 30, section 2.4, para. 1: will the herbaceous layer still be identifiable in the mid summer (sampling through mid-July)? I would think that many herbaceous plants, including grasses will be very dry and difficult to identify by this time. *(Comment 88: protocol developers and park managers discussed the ideal timing at length – managers are most concerned about trends in riparian shrubs and trees than trends in the herbaceous layer. In order to collect consistent data between data-collection years, observers must wait until full leaf out of the non-evergreen riparian shrubs and trees.)*

p. 32 - 34: I did not really follow the statistical details on power / ability to detect change. Will you really be able to detect a change in algal cover from 1% to 0.5% with these data? This seems unlikely given the broad classes that are proposed for use (or maybe I am misinterpreting

Tables 2.4 and 2.5.) As presented, I did not get much out of these sections in terms of statistical issues. *(Comment 89: removed power analysis. Please see reply to comment 43.)*

p. 48, section 3.5: is it realistic for staff to enter data weekly while also doing field work? *(Comment 90: The cost of weekly data-entry is built into the budget. Weekly data entry and updating the Principal Investigator / Project Coordinator is ideal so that observers can more-easily correct (and not repeat) data collection errors, rather than completing data entry at longer intervals. It is also ideal for observers to send data to the project manager frequently - for data quality checks and also to inform managers of weed- and wildlife-watch species as soon as possible for follow-up management action.)*

p.48, last para. I didn't see any previous mention of photodata (but maybe I missed that) *(Comment 91: photodata collection is introduced earlier in section 2.6.4.)*

Table 4.3 -- last column: is linear regression really the best approach. I could see many non-linear changes in data that might be useful for interpretation (interannual precipitation variation or outbreak of pests, etc..) *(Comment 65: see reply to comment 47.*)

p. 57, para. 2: what is the reasoning for the weekly reports. (*Comment 93: these are not weekly reports. As described in section 4.6 these are very informal weekly updates, which are for the purpose of good communication between the field crew and the (potentially offsite) Principal Investigator / Project Coordinator during the 10-week field season. As described in section 4.6 the weekly updates would consist of raw data, very rudimentary summary of the locations visited and weed- and wildlife-watch species observed only. Also, please see reply to Comment 90.)* This seems excessive/very frequent to me.

Reviewer #2 (R2)

This monitoring document is clearly very thoroughly thought out and documented. Most of the common issues associated with sampling have been addressed very thoroughly and it's clear the methods have been field tested for 'doability'. It's also really clearly written- thanks! That made it much easier to review.

My biggest **overall concerns** about the protocol fall into the following four categories:

1. **Too much ancillary data is being collected for which no use can be articulated right now**: The problem with this is that the monitoring becomes overwhelming and takes much more time than it needs to and, therefore usually, after a while doesn't get done at all so you don't even get the essential data. I would advocate sticking only to those things that really clearly yield results that will answer your specific questions as discussed in 2.6.1 to 2.6.3 of the document. *(Comment 94: removed 4 ancillary data collection items: Non-native annual grass abundance, depth of deepest pool, anthropogenic disturbance, and photodocumentation, due to concerns about relevancy of these data and investment needed to collect, store, analyze, and interpret the data. The other ancillary data are rapidly collected and will be valuable for interpreting landscape change at Pinnacles NM.*

- ***Vegetation Community:*** *Data collection is extremely rapid – observers will choose the appropriate community from the monument's vegetation key. These data will show trends in the evolution riparian vegetation communities are changing in the monument over time and help with interpretation in changes in the quantitative transect data collected by this protocol.*
- ***Non-native Annual Grass Abundance:*** *removed.*
- ***Plant Layers and Dominant Plants:*** *Data collection is extremely rapid, will assist with interpretation in changes in the quantitative transect data collected by this protocol, and also necessary for using the CRAM metric "vertical biotic structure"*
- ***Weed*** *and Wildlife Watch Species: These data are highly useful for management purposes as park staff are actively controlling these species. They will cost staff time only for the following: observers learning to identify the watch-list species at the beginning of the field season, observers recording any watch list species incidentally observed. Data will be anecdotal as observers will not be systematically or consistently searching for these species.*
- ***UTM Coordinates and Elevation:*** *These data are collected for the purpose of mapping data for presentation and use with GIS systems.*
- ***Rosgen Channel Type and Number of Bankfull Channels:*** *The reviewer suggested that instead of Rogen channel type, observers measure multiple channel morphology parameters (e.g., channel width, channel depth, floodprone area width.) This monitoring protocol does measure channel width (i.e., bankfull width) at each transect, but field testing found that measuring other channel characteristics was too time consuming and would not be repeatable without permanent markers in the field (these were infeasible due to park management concerns, channel evolution, and time required to re-find markers.) Rosgen channel typing is a rapid assessment of the relative stability and potential trajectory of channels, and is well-tested, rapid, and repeatable. These data will illuminate landscape evolution and help with interpretation of the quantitative data from the transects.*
- ***Depth of Deepest Pool/Run of Standing Water at Reachpoint Cross-section:*** *removed.*
- ***No or Limited Data Collected due to Hazardous Conditions:*** *The purpose of recording this information is not to show change over time, and there is likely substantial variation between observers regarding whether or not a reach or transect is safe enough for data collection. Other vegetation data gathered as part of this protocol are much better signals of change of vegetation density and surface water abundance.*
- ***CRAM-derived Metrics:*** *These metrics are collected to quickly and repeatably (Clark et al. 2006) capture observers' judgment of the condition of the reach. These will be converted into a GIS layer, based on stream reach UTM, to provide managers with overall single-visit assessments of the condition of stream reaches in the monument. Although CRAM metric data are categorical - not quantitative - and cannot be evaluated with parametric statistics, the percent frequency of values for individual metrics (e.g., how many reaches in Frog Canyon scored "A" for "buffer condition") can be tracked over time by reach in a stream to evaluate gross changes in condition over time.*
- ***Anthropogenic disturbance:*** *removed.*
- ***Photodocumentation:*** *Collection of these data requires little time in the field but require considerable effort for data storage. Removed.)*

2. **Exclusion of groundwater-dependent wetlands such as springs from the assessment**: If one is interested in the status of wetlands in California, particularly in the Coast Range area, I

think it is missing the big picture to exclude groundwater-dependent wetlands and to focus only on wetlands associated with streams. *(Comment 95: The San Francisco Bay Area Network ranked "wetlands" as the 11th most important vital sign, and described a desire to track changes in abundance of wetland habitat at the landscape scale for Pinnacles NM, Point Reyes NS, and Golden Gate NRA. This Pinnacles monitoring protocol was developed in response to that prioritization. At Pinnacles NM virtually all of the springs are not wetlands – generally these are represented by small areas where water emerges from rock with no soil development and few plants. Other springs are represented by damp soil under heavy evergreen canopy without a preponderance of wetland plants or, upon investigation, hydric soils. These systems may be ecologically important to the overall landscape by contributing water through the groundwater table to the riparian system through the summer, but they are not local hotspots of biodiversity. There are two groundwater-driven systems in the park that are clearly old, developed (i.e., with hyrdic soils and a dense canopy of wetland plants) wetland "springs" – McCabe Spring and Willow Spring. These two very-different systems (one dominated by a dense willow thicket, the other by Juncus and Nassella species) surrounds and heavily influences the flora of a portion of the adjacent creek system (McCabe Spring sits on and adjacent to McCabe Creek, Willow Spring sits on and adjacent to Upper Chalone Creek. This monitoring protocol will detect changes in the flora and geomorphology of the creeks adjacent to these groundwater-driven system as a part of its landscape-scale monitoring. At the beginning of the design process for this protocol the network and the park staff evaluated whether to monitor all in-channel wetlands and the riparian zone throughout the park (what we eventually did) – or whether to design two protocols to track changes at these two specific spring wetlands. All staff agreed that monitoring these two small sites is a park-level task and recommended moving forward with designing a landscape-scale protocol for in-channel wetlands and riparian systems. The park is proceeding with developing a monitoring protocol to meet their specific management concerns at McCabe Spring).*

I have some suggestions of resources that can help one think about how to monitor these, as well as some contacts of folks who are developing protocols for assessing these ecosystems. In actual fact, the groundwater-fed wetlands, assuming your assumption of deep groundwater sources is correct, are more likely to be stable naturally than are many of the riparian wetlands that are included in your analysis; as a result, if the extent of these wetlands changes then you know you have an issue whereas if the extent of riparian wetlands (especially as you've defined them – see the next comment) changes then it's hard to know whether you really have a management issue or not. Please note that I am not picking on this just because we've worked on groundwater-dependent ecosystems for the past few years, but rather because it's such an under-recognized resource and often passed over AND there are easy ways to evaluate the status of these ecosystems and to identify them in the field so they should not be over-looked, especially in more arid systems. *(Comment 96: see reply to comment 95)*

Suggested resources:

- Brown et al., 2007: *Groundwater and Biodiversity Conservation: A Methods Guide for Integrating Groundwater Needs of Ecosystems and Species into Conservation Plans in the Pacific Northwest.* See the Wetlands sections.
  http://www.waconservation.org/collinsGroundwater.shtml

- The US Forest Service and The Nature Conservancy have been working on monitoring protocols for groundwater-dependent ecosystems. In about a year it will yield a GTR but for now you could contact Allison Aldous (aaldous@tnc.org); Joe Gurrieri (jgurrieri@fs.fed.us); and Chris Carlson (ccarlson@fs.fed.us) for more info on their approach.

3. **Inclusion of riverine wetlands and lumping of those wetlands with palustrine, streamside wetlands in the analysis**: The true riverine wetlands are very variable responding in location, extent and even presence to stream migration and scouring that can vary a lot depending upon precipitation patterns in a given year; granted these things can also change due to land management and water issues but the natural variation seems to me will swamp out (or easily could swamp out) the signal from these anthropogenic sources. Because the protocol doesn't separate out those streamside wetlands that are more permanent from those that are ephemeral I think it will have trouble yielding important results. *(Comment 97: there is some debate among federal (NPS, USFWS, FS) personnel and protocols with respect to whether "small" streams – such as those at PINN – should be classified in the Cowardin Riverine or Palustrine system. It's a bit of a semantics issue for this protocol, as PINN has no large rivers. The USFWS National Wetlands Inventory – the main user and developer of the Cowardin system – reserves the "Riverine" system for large, permanent rivers and classifies smaller, ephemeral streams as Palustrine. This is supported somewhat (although not clearly) in the 1979 Classification. This PINN protocol follows that convention, so there are no "Riverine" wetlands at PINN (as stated in SOP 5). Also there are no isolated streamside (i.e., floodplain) wetlands at PINN. And yes, the protocol developers expect that some wetlands will move upstream or downstream in the channel system due to stream migration, channel bed movement, and scour . . . but that the metric of interest is: is the amount of wetland habitat increasing or decreasing across the landscape overall. Some wetlands may never migrate because they are fed by deep, permanent aquifers, and this protocol will eventually differentiate those wetlands that are stable in the landscape from those that are expressions of the surface and near-surface stream flows (this is described briefly in section 2.1.2). It is simply not possible to distinguish at this time whether an instream wetland is fed from this year's rainfall or is fed by a permanent deep aquifer. The repeated surveys required to answer this question have not been done, this protocol would do that. However – based on discussions with park staff that have observed changes in the stream system after several large flow events, we assume that "permanent" in-stream wetlands fed by deep groundwater are very rare. It is possible that the "ephemeral" instream wetlands would increase in abundance just enough to offset a decline in the abundance of "permanent" wetlands (possibly due to distant groundwater withdrawal), and therefore the protocol would yield an erroneous "no change" conclusion. However, there is no way at this time to avoid this problem, as we cannot distinguish these populations at this point. It is true of any monitoring protocol that unknowable variation in the target population may swamp fine-scale results (e.g., genetically disadvantaged birds may have higher mortality, but their mortality may be offset by better survival of their cousins. It may not matter to the monitoring protocol if it merely wishes to track overall bird abundance. For this protocol, we wish to track overall in-stream wetland abundance).*

For instance, if the more permanent streamside wetlands change in extent then that is perhaps something to be concerned about but, with the current data analysis/ sampling protocol and the fact that these two types of wetlands are not distinguished between, the natural variability of the riverine wetlands may prevent these important changes from being seen. Suggested resources for being able to distinguish groundwater-dependent wetlands from other wetlands:

- Brown et al., 2007: listed above. The decision tree and discussion in Section 3.3.2 might help to be able to identify those wetlands likely to be maintained by groundwater.

- Jeanette Howard, of TNC in California just completed an assessment of the importance of groundwater to ecosystems, based on some methods that we developed in Oregon and Washington (Brown, 2009; *Groundwater-Dependent Biodiversity and Associated Threats: A Statewide Screening Methodology and Spatial Assessment of Oregon.* Available at: http://www.waconservation.org/collinsGroundwater.shtml). You could contact her at jeanette_howard@tnc.org.

4. **Absence of triggers at which a problem would be declared or management changes considered:** In the protocols you do a nice job of explaining why historical condition cannot serve as a good goal or objective – I buy that, especially in this area. However, this does not excuse one from having to set the trigger points for each objective at which either further investigation or changes in management would occur. I think it is **very** important to articulate these trigger points up front because it helps you to think about whether your detection limits are adequate or too fine (i.e. your sampling is too detailed). This is a critical missing step – for both objectives (evaluating trend in wetland abundance and trends in riparian vegetation structure) the changes that would trigger new action and some sense of what that new action would be must be identified. *(Comment 98: see reply to comment 13)* Without that, this will just be an interesting annual report and not a good use of Park Service resources to have collected the data in my opinion. I harp on this in the following comments – sorry, but I think it's a huge issue.

Specific comments:
P. xiii: Link between monitoring results (metrics) and changes: I don't think that the monitoring as described here is going to provide much indication of surface and subsurface availability, due largely to my overarching concerns #2 and 3. I think if you want to know about surface water availability, you'd be better off identifying places where you expect that to change and then measuring it (i.e. gaging of streams) or measuring the wetland response in only those areas. Similarly for groundwater – identify groundwater dependent wetlands and track changes in water level in some of the key places where you expect changes might occur (however, I think sorting out how you really think groundwater works here with a conceptual model would be an important precursor to this). *(Comment 99: our current conceptual model of the relationship between groundwater and surface water is laid out (briefly, with references) in section 1.3 of this protocol. The USGS groundwater hydrologist who has studied this area most extensively – Jim Borchers – has told the park that gaining a true understanding of the subsurface flow paths of this park on the San Andreas fault would be a tremendously expensive and invasive undertaking (i.e. hundreds of groundwater monitoring wells and piezometers collecting data, as well as water chemistry analysis for age and flow path). Furthermore, he explained that simply measuring changes in groundwater at several places in the park with wells would be problematic because a detailed understanding of the groundwater dynamics does not exist (I have a lengthy memo from Borchers describing the difficulty in measuring groundwater directly at PINN which I can forward if required). Also, as described in section 2.2 of this monitoring protocol, gauging the*

sandy, highly mobile creeks in this park is notoriously difficult. USGS hydrologists have told the park that this is a non-trivial problem for them – and their standard gauges cost over $100k per year to operate if we were to contract a stream gauge with them. The park is attempting to gauge two creeks in the park, however, the only candidate creek that can support a high-quality gauge is downstream of a large artificial impoundment and will not show a clean signal of long-term environmental change. Also, there are no specific, localized threats to groundwater – just a concern by park managers that groundwater pumping outside the park could impact groundwater availability in the park. However, as there is little understanding of the groundwater flow paths for this park – other than that the water emerging from park springs is over 60 years old, as described in section 1.3 of this protocol, targeting specific at-risk groundwater-fed springs for monitoring is not feasible. As I tried to describe in section 1.6, this wetlands monitoring protocol will help to inform the park about long-term changes in water availability in a landscape where water quantity cannot be monitored directly without great expense and technical support. This protocol is primarily focused on changes in a water-dependent habitat, not water availability itself . . . but data from this protocol will help managers infer trends in water availability).

p. xiv: Dan Salzer is one of my monitoring and measures of success gurus too! He's fabulous, no?

p. 3 last paragraph, second to last sentence: Palustrine wetlands can have water sources that are surface water, not just groundwater or subsurface hillslope (or is hillslope supposed to mean surface water?). *(comment 100: **edited** text)*

p.7: This relates to interpreting the information on substrate changes etc… It might help to stratify streams by geomorphic position (e.g. source, transport, depositional reaches) as that can govern substrate size. Then changes in substrate size might be more detectable in a meaningful way – i.e. you'd know which part of the watershed was most altered, which might yield some more info about sources of alteration *(Comment 101: this sounds like a potentially highly-valuable post-hoc domain identification for data exploration)*

p. 12: I'm glad to see you discussing and considering groundwater and springs; however, I just wanted to encourage you to make sure that you really do think the source of all the springs is deep groundwater. If it's more local groundwater (common for smaller springs) then these too can be less consistent in their presence and size. Also, that means that local wells and other activities (such as for cattle watering) can affect these wetlands. *(Comment 102: this assumption is based on USGS investigation (Borchers and Lyttge referenced on page 12) and interviews with families that have ranched in the area for a century (Babalis, referenced on page 12). There are no ranching activities upgradient of any known springs/seeps at PINN.*

p.14: Need to bold 1.4.1 title. *(Comment 103: **edited** text)* Really glad to see that you mention the problems with continually updating protocols and how that renders the results difficult to use!

p.14-15: I found this section tricky to understand in places. The phrase 'this protocol" seems to be used interchangeably to mean this document and the protocol being discussed in a particular section (e.g. 1.4.6 – first sentence – what does 'this wetlands monitoring protocol' refer to? The NPS doc I'm reviewing or the Network Amphibian Monitoring Protocol?). Same throughout that section and the next. *(Comment 104: thanks for the observation, **edited** to clarify text throughout these sections)*

p.16-17 (Section 1.6): I just do not agree with the conclusion in this section that no triggers need to be set. Looking just at the 3 sets of data meant to address the specific objectives (and

excluding all of the ancillary data that is proposed for collection), I don't see much value in collecting this information if there are no quantitative triggers that would indicate or should indicate to park managers that something is amiss or that all is fine. Without these triggers, each year the managers will get an annual report with summaries of the findings but they will have almost no idea how to interpret that without some indication of what is acceptable change vs what is not. I fear that without these triggers, this will just produce report after report but no one will have a clear sense of how to interpret the results. Even though we don't exactly know how much change is acceptable, I would think you could put together some best guesses of what changes would indicate further investigation is warranted. For me this is a necessary part of any monitoring program and it seems it is expected here as one of Jim Agee's questions is 'are there measurable objectives? ' and right now the answer is no. *(Comment 105: see reply to comment 13)*
Also, in the second paragraph on page 17, I am not at all sure that analyzing these data by watershed is going to illuminate effects of local water withdrawal. Local water withdrawals may not be easily indicated by analysis at the watershed scale as often the effects are on a much smaller scale. *(Comment 106: **edited** text)*

The discussion about the importance of the ancillary data does not indicate value to the 3 questions that are to be addressed by this monitoring protocol. If these data are important to collect, then the objectives that they will be used to evaluate should be identified, as well as the quantitative triggers at which management action is needed. If this is just a matter of doing some other program's work while one is out in the field, then I don't think it needs to be integrated into this protocol – it should just be put in the work plan of the field staff so that they are using their time and travels most efficiently. *(Comment 107: see reply to comment 94)* When it's included in this protocol, it really muddies the waters regarding how the 3 main objectives will be evaluated.

Finally, I am wondering if you might just want early warning indicators that something has changed in wetland abundance, rather than detailed indicators that might take a while for changes to affect? *(Comment 108: see reply to comment 94)* It's just a thought that quicker, more easily assessed factors might get you to your end result more efficiently. In the end with the current indicators for Objectives 1-3, you'll just be able to say that the evidence suggests something is changing and then more work will be needed to say what's causing it. That makes me wonder if you could do something much easier to get to the point where you know something changed – for instance, a remote sensing exercise or photopoints or just the wetland areal extent at some sampled places, rather than everywhere or instead of the detailed plant canopy measurements. Not sure but it is a thought because I'm not sure of the increased utility that you'll get from the more detailed data over more 'red flag' indicators. *(Comment 109: protocol developers and park staff carefully evaluated whether developing a remote-sensing protocol would meet objectives, and concluded that changes that park managers wished to detect (i.e., declines in wetland abundance and riparian canopy cover) could not be adequately tracked with imagery. Also, this protocol is decidedly not intended to determine any causes of changes).*

p. 19 2.1.2 – As mentioned in my upfront comments, I do not see monitoring of groundwater-dependent wetlands as that different from monitoring of the streamside wetlands, necessarily. And, more to the point, I think by excluding these wetlands you are missing a really important component of wetlands in this monument. I am unconvinced one needs to monitor wetland water chemistry in order to evaluate changes as usually those changes come from alterations to flows… and flows can be measured either as water table elevation or wetland extent. *(Comment 110: see reply to comment 95. USGS groundwater hydrologist Jim Borchers has conducted the most extensive investigations of PINN's springs, and recommends that we evaluate groundwater chemistry of these springs. Most of these springs do not support wetlands, so measurement of wetland extent as an indicator of change is infeasible. Water table elevation cannot be measured for many of these springs because the water emerges from rock).*

p. 20 see my upfront comments about the need to stratify between riverine wetlands and more permanent streamside wetlands. I think it should be possible to identify groundwater-fed or more permanent streamside wetlands from the riverine wetlands in the field, even if such stratification hasn't already happened (see my earlier resources as suggestions). *(Comment 111: see reply to comment 95)*

Also, perhaps you can actually sample all parts of the monument but it's a labor intensive effort (2 people, 10 weeks, 3 years) so I think it is worth considering whether sub-sampling might be in order so this effort can be completed in say one field season every 4 years or something that is affordable and efficient (and therefore more likely to continue over many years). This is again addressed in one of my upfront comments about trying to do too much. *(Comment 112: protocol developers and park staff considered developing a protocol based on local, intense sampling but determined that a) we wanted a protocol that included the entire stream network, not just some sections of some streams and b) that because in-channel wetlands frequently move around within the stream system with PINN's rapid geomorphology evolution that intensely sampling a permanent "wetland" area could send a false signal of change (i.e., when the system rearranges itself after a flood, the permanent area may no longer be a "wetland" area – indicating a wetland decline – but a new wetland area may establish elsewhere in the system that would not be picked up). This is described in Section 2.1.2. Also, I'm afraid you may have misunderstood: this protocol takes only one season to complete (not three years). It would be repeated every third year. And with the ancillary data removed by reviewer request, it will be very extremely rapid – without sampling.* ***Edited*** *text to attempt to clarify).*

p.22 and 23 (Sections 2.2.1.1-2.2.1.3): I would suggest that each of these sections should make it clear what questions will be answered by collecting these data. *(Comment 113: see reply to Comment 84)*

You did a nice job of this in Section 2.2.1.3 (trends in substrate and riparian canopy cover) although I am still not sure how you'll interpret that data but that is a separate issue. *(Comment 114: see reply to Comment 94)*

Could you have a similar type of statement for the dominant canopy cover and the presence of wetlands in the bankfull banks? *(Comment 115: don't understand request)*

Section 2.2.1.1 My experience collecting species and cover data is that it is very tricky to interpret, unless one is just looking for indications that a threshold cover of an exotic species has been exceeded. Otherwise, the abundance and dominance of many of the native species changes over time, often not in a unidirectional way, and if we haven't set triggers for action then we don't know whether those changes are good or bad. It is for this reason that I really advocate the identification of triggers – what kind of change in species dominance would indicate a problem- and I would suggest really considering whether you need this abundance data to draw these conclusions (as it's time consuming to collect and often not easy to interpret). *(Comment 114: see reply to Comment 94)*

Section 2.2.1.2 I am worried that you are using bankfull widths as your sampling area for wetlands. I'm not familiar with this landscape specifically but in many places this would exclude the sampling of streamside wetlands that are not within the high flow (prior to flooding) width of the stream. That seems like an oversight to me as it can miss floodplain wetlands. *(Comment 117: pilot data collectors investigated this concern and interviewed park staff very familiar with the park's riparian areas: there are no isolated wetlands on PINN's generally small and arid floodplains)*

This is also the section where I started to be more bothered by the inclusion of riverine wetlands that are really variable in extent, in response to stream scour and high flows, without their stratification from streamside palustrine wetlands. *(Comment 118: see reply to comment 117)*

p. 25 Section 2.2.2.2: See my earlier comments about using bankfull width as your measuring extent for riparian vegetation – what about the floodplain vegetation? (Using the definition that bankfull is the width of the stream just prior to overbank flow during floods). *(Comment 119: protocol developers and park staff considered evaluating riparian vegetation across the entire floodplain (or "floodprone area") but in the field this proved to be too time-consuming for ancillary data collection).*

Could you describe what you are looking for with the guild analysis and the gravelometer work? *(Comment 120:* ***edited*** *text in section 2.2.2.2 to clarify)* And again, what kind of a change in those parameters would indicate a problem. *(Comment 121: please see response to comment 13)* I'm a bit worried (although this is not my area of expertise) that the substrate size might vary depending upon the position of the reach within the stream network (i.e. whether it's depositional, transport, source, etc…) – I guess you are analyzing changes in size so maybe that would work but would you also not expect the variability over time to be different in these different types of reaches? I'm not sure of the answer to these questions but, if you haven't, would suggest talking with a stream hydrologist. *(Comment 122: a network hydrologist reviewed this design)*

p. 29 Section 2.3: Your comments about the metrics not being sensitive to small changes makes me wonder if these indicators are really at the same scale as the changes you are hoping to identify. This isn't clear to me in this document but if you're trying to see changes from water availability I think those will be fairly local possibly and if you want to see effects of feral pigs, won't those be local too? I guess I am not convinced (and maybe it's just a matter of how things are written and the fact I've not been to Pinnacles) that these indicators are going to get you the scale of information that is useful from a management perspective to identify these local scale threats. *(Comment 123: see reply to Comment 94)*

p.32 Section 2.6.2: I am wondering how you will interpret the changes in the average number of guilds encountered in stream transects. I'm not sure more is better or that less is better – doesn't it in part depend on the topography and landscape position, relative to the stream? This is one case where it would really be helpful to know what kind of a change would be seen as problematic. *(Comment 124: see reply to Comment 13)*

In Table 2.4, some of those change detection capability numbers are pretty big. So again, identifying trigger points would help one evaluate whether they are too big. Would knowing there is a 50% change in algal cover mean that a huge change had already taken place and that you're learning this way late in the process of significant alterations actually occurring in the wetlands and streams? *(Comment 125: see reply to Comment 13)*

p.34 Section 2.6.4: This is the ancillary data section and as I mentioned upfront I don't see much value in these data being collected as part of this protocol as they don't answer the questions. *(Comment 126: see reply to Comment 94)*

I have some specific concerns, should you decide to collect these data:
Non-native annual grass abundance: I just wondered if you really care about the abundance or if you just care that it's present or that it's over 25% (for example) of the area. *(Comment 127: see reply to Comment 94)*

Plant layers: Again, I am not sure how you would interpret these data for making management decisions or even how you'd interpret them to say that a good or bad trend is occurring. *(Comment 128: see reply to Comment 94)*

Rosgen channel type: If this is important, why not just measure the channel cross-section in key places and see if it's changed in w/d or other key factors, rather than waiting for a shift in Rosgen type, which seems less sensitive to me *(Comment 129: see reply to Comment 94)*
Max pool depth: This one really bothers me *(Comment 130: see reply to Comment 94)*
– first you have to find the deepest pool, which perhaps isn't that time consuming in this landscape, but then I really don't see how this informs about water availability? It's so variable depending on flows and those vary depending on precipitation. The values (pool depth) could also change if the pool fills in a bit – which might then be used to indicate loss of water availability when in fact that isn't the issue. It seems some erroneous conclusions could be drawn pretty easily if these data are used in this way… if an indicator of water availability is needed then I think you'd be better off gaging the stream or looking for changes in the extent of the stream bed that is dry late in the season … or some other things that more directly get at this issue.
Section 3: This is very clearly written – one can imagine actually doing the field work and most details seem to have been thought of. The point sampler raises some questions for me but if you've field tested it and it works effectively in your terrain then it seems reasonable, although labor intensive. I wondered about entering the data electronically as you go rather than on field sheets – it would remove the data entering step – and my sense is that these have improved so much lately that they are much more user friendly and reliable than they were in the past. (Comment 131: protocol developers and park staff may move to an electronic data collection

format when the protocol metrics have been finalized, however, paper data sheets will still be required as back-up)
Remainder of the document: these are not my areas of expertise so I don’t have any comments on them.

Appendix SOP 1 C. PWR Protocol Review Checklist.

This appendix documents additional peer review comments and the writing team's responses. Responses in blue are from Marie Denn. Other responses are either from Dave Press (DP), Data Manager, SFAN Inventory and Monitoring Program or Marcus Koenen (MK), Program Manager, SFAN Inventory and Monitoring Program.

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April 5, 2010

The review of the revised Protocol for Monitoring **Riparian Habitat and Associated Wetlands in the Pinnacles National Monument, San Francisco Bay Area Network of National Parks**, has been completed. The protocol decision is

NEEDS MINOR REVISION

We appreciate the rapid response and attention to review comments that were completed on this protocol. Dr. Latham and I thought that most of the technical aspects of the revision were well done and the response to reviews adequate. However, there are some technical aspects of the protocol that still need to be addressed, and many minor editorial details. Among the content issues:

- The three-sentence Executive Summary is insufficient to guide the reader through the purposes and plans of the protocol.

  A more complete executive summary has been added.

- It is not clear who the responsible person (Principal Investigator) is on the protocol and for some other functions (like timelines). Please identify.

  Identified myself – Marie Denn – as the principal investigator.

- Is Sudden Oak Death an issue at Pinnacles, and if so, how will sampling address it?

  Sudden Oak Death does not currently occur at PINN. Furthermore the park is in the lowest risk category for Sudden Oak Death as assigned by the state of California, due to its very low humidity. However, the park vegetation specialist, Brent Johnson, is developing a protocol for early detection monitoring for Sudden Oak Death separately from this protocol. He does not advise adding Sudden Oak Death monitoring to this protocol.

- The CRAM metrics are not really ancillary data, but data that will be collected and analyzed. Yet there are not objectives, or techniques for analysis. Please include these in the next draft.

  I strongly disagree. CRAM assessment scores are categorical and qualitative and are unsuitable for objective setting.

  The categories of information to be collected - adopted from CRAM - include general observations such as: the shape of the stream channel, number of overlapping plant layers observed (*i.e.*, vertical vegetation complexity of the riparian vegetation community), the number of habitat patches ("habitat patches" as described by CRAM), buffer status (best match of "buffer status" from several narrative descriptions), etc. These categories together describe the observed habitat, and together may be used to describe the general configuration of stream channel habitat at Pinnacles NM . These data are categorical, and are intended for display on maps (see section 4.6 of the protocol for recommended reporting format), not for numerical change-detection analysis.

  It is not reasonable to assume that there is a preferred state for CRAM metrics such as the number of habitat patches, shape of the stream channel, or number of overlapping plant layers in the riparian forest. The state of knowledge of riparian communities at Pinnacles is not adequate to establish that more/fewer habitat patches, or more/fewer overlapping vegetation layers (for example) would be represent better ecological functioning, or to establish that changes in these metrics would represent degradation of the riparian system. However, for the quantitative metrics tracked by this protocol there is confidence that decline in wetland abundance, change in riparian community composition, or substantial change in stream geomorphology may represent degrading habitat conditions warranting investigation of potential management action.

  CRAM's coarse, descriptive rapid-assessment metrics are not adequate for formal monitoring purposes; instead they provide a mechanism to formalize general environmental observations by field staff. In this way, CRAM data are similar to photodocumentation - qualitative information about the type of habitat observed. Qualitative environmental information, such as photodocumentation and constrained choice observational metrics like those in CRAM, often provide critical information about change over time, most particularly to provide context for quantitative data revealing large environmental changes. However, I removed text from the protocol that the reviewer perceived as implying that CRAM metrics would be used for quantitative monitoring purposes.

  I believe that use of the CRAM metrics effectively, repeatably, and efficiently captures observations from field staff that will be valuable to future managers, but I consider creating management and monitoring objectives for CRAM metrics to be inappropriate. If the reviewers disagree with my assessment that CRAM metrics will produce valuable rapidly-collected ancillary environmental data I will remove all reference to these from throughout the protocol and limit data collection to the three quantitative metrics proposed.

- Measurement of cover in SOP #5 is not clear enough to guide the reader (or technician).

  Edited text on page 5.6 part c to clarify

Best of luck in finalizing the protocol and getting it implemented on the ground.

Sincerely,

James K. Agee
PWR Protocol Review Coordinator

Attachments: Agee and Latham reviews

Review of Pinnacles Riparian Habitat (April 2010)
J.K. Agee

Title Page: I believe the location of PORE is Point Reyes (yes, thank you for the catch)
Xiii: Page number for Appendix A is not defined. (edited protocol)
Page 13, par 1, line 1. Space between "contains" and "19". (edited protocol)
Pages 14, 15: Italics on all Latin names (many here). (*MK: italics added on pages 14, 15, and throughout document*).
Page 16, last line. Gardali et al. will be 2010 (edited protocol, and list of references in the back of the document,)
Page 17, sec 1.6. Needs a space between paragraphs 5 and 6 on this page. (edited protocol)
Page 22, par. 3, line 3: "One third of these reaches will be evaluated each year.." (edited protocol)
Page 22, untitled table, line 2: Vegetation, rather than Vegetaion (edited protocol)
Page 23, line 3: kilometers (edited protocol)
Page 25, last par. Now I understand the 100-m reaches are measured along the thalweg, not a lineal line. (thank you for the comment)
Page 26, line 4 from bottom. One more "Environmental Research" that should be "Environmental Laboratory". (edited protocol)
Page 29, par 3,4: "…riparian areas at Pinnacles NM" should either be fused in the same paragraph as "the vegetation community changes" or a space for a paragraph break added. (edited protocol)
Page 34, last line, and page 35, first par, last line. I think you mean two rotations so there are two sets of measurements for each stream? If two years is meant, then only 2/3 of the data will have been collected once. (yes, edited protocol)
Page 51, par 6, line 5: Palmer ref missing from lit cited. *MK: added*
Page 54. Italics on species mentioned in "example summary statements". *MK: fixed*
Page 69: extra space between Brown et al. and Bunte and Abt. (edited protocol)
Page 69: Collins et al.: title is orphaned to following page. (edited protocol)
Page 70, CRWR. Because this reference is listed as CRWR in the text, it is properly located in the lit cited, but the acronym "CRWR" should precede "Center for Research…" in the citation (refer to CNPS above as an example). (edited protocol)
Page 70. The DeLeo reference is spelled "De Leo" on page 4. Space or no? ("De Leo" - edited protocol)
Page 70. Gardali et al. will be 2010. (thanks, edited protocol)
App. A-5, Table A.3: The word "shrub" (first column) is split. Maybe adjust font size? (edited table)
SOP 5.4, Plant Species Lists, line 4: Latin name italicized. *MK: fixed.*
SOP 5.5, last text line: Latin name italicized. *MK: fixed.*

SOP 5.6. In the techniques, I was not altogether clear about section "b". I would think, if cover is being described along a 100-m reach, that 1 m of reach would constitute 1%, but it is described as 1 m of width? This needs to be better described for people (like new BTs) working with the protocol. (thank you for noting this, edited protocol to attempt to clarify)

Table SOP 5.2 Normally the Latin names would be italicized, but perhaps the original publication from which these were taken did not italicize them. If the latter is true, then OK, but if not, italicize the Latin names in the table. *MK: Scientific names were italicized in the original document but removed by the technical editor. We put them back in.*

SFAN: Pinnacles Riparian Habitat and Associated Wetlands Protocol
Final Administrative Review, Penny Latham, April 2010

For the final administrative review, I read the Narrative section thoroughly except for the Literature Cited. The SOPs were read with less attention to detail except in areas where I had questions or reviewers had made significant comments. Based on the previous reviewer's comments, this protocol seems to have been significantly revised and improved and the authors were responsive to the majority of reviewer's comments. It is organized well over all and most areas are clearly written. The authors clearly identify the inference and analyses they hope to conduct related to the primary objectives of the protocol. However, there are still many small editorial errors in the narrative in particular (listed below). In addition, I have some questions related to ancillary data and other content in a few areas.

Comments on Content:

- I found the Executive Summary not well developed and think that the authors need to expand this section. The purpose of an Executive Summary is to summarize important aspects such as objectives, methods, and expected products and is quite different from an Abstract (I'm not sure the material presented even meets the criteria for an Abstract).

  (Please see discussion on page 1 of this document)

- I am concerned about the potential to spread the organism for Sudden Oak Death among the various streams (or invasive aquatic species encountered). SFAN is severely affected by SOD with already documented mortality and loss of canopy cover. There is no SOP related to cleaning of vehicles, boots, and other clothing or equipment from stream to stream. Perhaps PINN is too dry and SOD is not a concern there, but I think some discussion is warranted given the severity of the problem in the Bay area in addition to the potential to spread other invasive aquatic species.

  (Sudden Oak Death does not currently occur at PINN. Furthermore the park is in the lowest risk category for Sudden Oak Death as assigned by the state of California, due to its very low humidity. However, the park vegetation specialist, Brent Johnson, is developing a protocol for early detection monitoring for Sudden Oak Death separately from this protocol. He does not advise adding Sudden Oak Death monitoring to this protocol.)

  (At present, there are no invasive aquatic species of concern at PINN that can be spread by equipment. Training for prevention of spread of invasive species that may be of concern in the future will be conducted by park staff as part of the early-season training described in section 6.2.2 of the protocol.)

- There is no comprehensive schedule that shows individual responsibilities for activities and products and a timeline. While there is discussion related to the Project Coordinator, Data Manager, Network Program Manager, and the field techs, I was not convinced that this protocol would have someone that is considered the PI and is responsible for not only annual summary reports but will also conduct in depth periodic status and trend analyses. I would like to see this aspect of the protocol clarified. I find it doubtful that the Network Program Manager and the Network Data Manager will be able to provide this function given their many other responsibilities. Also see other comments in this section below.

(Identified myself – Marie Denn – as the principal investigator.)

- Ancillary data: The authors explain away some of the ancillary data collected and have also removed some of the ancillary data collection from the protocol. However, the CRAM rapid assessment data collection methods do not seem to me to fall into the category of what I would consider ancillary data. There are several different metrics collected, they are reported on, and the authors state on pg. 36, "…they can be tracked over time by reach in a stream to evaluate gross changes in condition over time." The authors also warn that from a monitoring perspective that the CRAM methods should not be updated for this protocol if that should occur. On pg. 26, authors state that CRAM data will reveal patterns in wetland abundance at a landscape scale. I would conclude that this data collection effort needs to have an objective, methods (which it does), and discussion of appropriate analytical methods and conclusions.

  (Please see discussion on page 2 of this document)

- Pg. 35 – No or Limited Data Collection… This description sounds like this call could be quite variable and change among surveyors. Somewhere later in the protocol you state that the call tends to be consistent, but I would suggest clarifying this. A place that is determined to be hazardous by one set of surveyors should not then be included in the monitoring by another set of surveyors at a later time.

  (During the pilot we visited only about 7% of the potential sites and observed areas that could not be sampled due to dense vegetation, toxic vegetation, dangerous fauna - *e.g.*, wasps, bees - and oversteep terrain. Due to the limited range of the pilot area we could not evaluate all the potential reasons that an area would be too unsafe to sample. During the first full year of data collection the list of reasons that a site cannot be sampled will be further defined and documented. However this cannot ever be codified as a complete list, as future observers may feel unsafe in a various conditions, and it will never be acceptable for observers to be required to sample unsafe areas. Some areas may be deemed unsafe due to relatively permanent geomorphic conditions and permanently thrown out of the study area.

  However, it is not necessary to permanently throw out all sites that are determined to be unsafe one year by one set of reviewers (from Cochran 1977 *Sampling Design* and John Willoughby, co-author of *Measuring and Monitoring Plant Populations* with Elzinga *et al.*, personal communication). This is a very long-cycle monitoring protocol, and conditions may change dramatically between monitoring cycles – particularly with respect to dangerous vegetation and fauna. For the wetlands abundance metric, the observation area for each year will be defined as all riparian areas within the sample area that are safe for observers, with acknowledgement that this may slightly underestimate vegetation cover (as described in the draft protocol), creating an unavoidable but assumed small bias. However, this protocol also relies on comparing paired transects (*i.e.*, transects that are positioned in the same location each sampling year) for evaluation of changes in vegetation community composition and channel characteristics. For these metrics when individual transects are not observed in one sampling year due to hazardous conditions, then a Maximum Likelihood Estimator will be used to replace the missing value (Shafer 1999, Shafer and Olsen 1998). Analysis with MLE approximation can be conducted in R software (demonstrated in Appendix B of the draft protocol) with the "nlm" function.

The alternative – to throw out all units of the 466 sample units that have ever been deemed by any observation team to be dangerous ("listwise deletion") – unacceptably results in a continually shrinking number of sample units. However, in future years investigators should evaluate if some sites are always deemed unacceptable due to hazardous conditions, and permanently removed from the study area. The number and location of sites that are not sampled each year will be recorded for future reevaluation of the potential bias and assumptions.)

- This may be more about semantics than anything else, but most protocols refer to the Master Database as the one that is retained on the network server. The database used each year is referred to as the "working copy" and QA/QC is performed on that database before incorporating the results into the Master. It probably doesn't make any difference as long as there is a back-up copy somewhere and the QA/QC gets done. *MK: In other cases we have multiple working databases that are eventually merged into the master database. In this case, there is only one main database and it seemed reasonable to refer to it as the master. Yes, backups are mainted offsite.*

- Pg. 52 refers to the data life cycle but it is never described or referenced. *MK: this was confusing and reworded slightly.*

- Pg. 52 – Section 4.3.2, paragraph 1. The paragraph states that significant database design "may" require approval by the Project Coordinator. This is another area that indicates to me that this protocol does not really have a home. Who is the PI? Significant changes should not be made to the database without the consent of the person who will be doing the primary status and trends analysis. Is this the Project Coordinator? It doesn't seem so. Please clarify. *MK: The role of the Project Coordinator is described on pg. 61 sectoin 5.1.3. This person oversees the program, reviews data, and completes annual and trend reports. The position is currently served through the PWR aquatic ecologist who is paid part time through the I&M program. If that person currently in the position leaves it is not clear if PWR will refill the position. In that case, we will have to rethink who serves as the Project Coordinator.*

- Pg. 63 – Last paragraph. This is another area that makes me wonder if there is a PI for the protocol. Training should be done by the person in charge of the protocol, not by a number of different people who may emphasize different things or provide inconsistent interpretation. *MK: the section now clearly states that the Project Coordinates provides the training. This will ensure consistency from year to year.*

- The Job Hazard Analysis was very complete and well thought out. However, there was little discussion related to Safety in general or guidance for field staff on check in/out procedures, how to get help, who to contact, etc. Is this information provided elsewhere?

  (Safety is discussed both in the JHA and then briefly in section 3.1.1. Park staff familiar with conducting fieldwork at PINN will train field staff for this protocol. The PINN Chief of Resources Management is the primary contact for safety training, as described in sections 3.1.1 and 6.2.2)

Editorial Comments:

- All figures, tables, appendices, SOPs should be referenced in the narrative. I could not find references to the following: Tables 4.1, 4.2, 4.3, 6.1; Figures 2.3, 3.2, 3.3, 3.4, 3.5, 3.6 (3.3 – 3.6 are referenced as datasheets but no figure number is given); SOPs 1 and 6. (edited text)
- There are several places throughout the document (not just in the section referenced on pgs. 14-15 where species names are not italicized. Please search these out and italicize as appropriate (e.g. everywhere where not found that way in another document). *MK: species are now italicized.*
- Delete directional adjectives when referring to a table or figure or other section (e.g. See Section 5.2 below should just refer to the section). There are several areas where this occurs and a few are confusing because of formatting. *MK: many of these directional adjectives were removed. Some were left where appropriate.*
- I thought the repeated reference to The San Francisco Bay Area Network of National Parks was a bit awkward and wordy. Most protocols just use the network name by itself or may say the parks of the SFAN, or if Pinnacles is the only park just refer to PINN, etc. Just a thought. (deleted "of National Parks" from many of these instances)
- Pg. ii – This is not the current template page. It is missing the statement regarding peer review. *MK: Cover pages replaced with most current versions including most current boiler plate language. Last two pages replaced as well for good measure.*
- Pg. ix – Typo in Fig. 1.3 caption (here and on pg. 12) (edited caption)
- Pg. xiii – Page error in TOC *MK: page errors were fixed.*
- Pg. 12 – Caption separated from figure (fig. 1.3) (edited caption)
- Pg. 13 – I think Table 1.3 on this page should be Table 1.2. (this is ok in my version of the protocol)
- Pg. 15 – Paragraph 2, I would suggest deleting the colon at the end of this paragraph. It is usually used to indicate a following list instead of several chapter sections. (edited text)
- Pg. 15 – Section 1.4.2. Delete "of" before "Network" (edited text)
- Pg. 15 – Section 1.4.3, l2 from bottom. In this case the possessive apostrophe would go after the "s" not before it. It appears that way on the following page. I would recommend simplifying this phrase. " (edited text)
- Pg. 17 – Section 1.6. Line needed between paragraphs 1 and 2. " (edited text)

- Pg. 17 – Section 1.6, paragraph 2, line 3. Replace "is" with "are". " (edited text)
- Pg. 18 – First sentence. Substitute "determined or agreed upon" for "concluded"? " (edited text)
- Pg. 18 – Obj. 1. Unclear. " (this has text has been through multiple revisions. Unclear on how to improve farther)
- Pg. 18 - Obj. 3. Delete one "change" " (edited text)
- Pg. 18 – First sentence. Correct phrase about p-values " (I don't understand what correction is being requested)
- Pg. 22 – Table does not have a number or caption, vegetation misspelled (fixed spelling error; *MK: table is numbered).*
- Pg. 24 – I was confused by the reference to red squares in the legend. There are red boundary lines and red diamonds but I didn't see any red squares. (edited caption)
- Pg. 26 – Sect. 2.2.1.1. Last sentence refers to section 6.4 for schedule apparently but 6.4 = budget. (this reference is not intended to lead readers a schedule, rather to point readers to the analysis that IF technicians can indeed complete the surveys in 10 weeks (as asserted here, based on pilot testing) that the network can afford to implement this protocol with the current allocated funding. Edited text to attempt to clarify)
- Pg. 27 – Paragraph 3, line 5. Delete "in" before "at Bear" (edited text)
- Pg. 30 – Paragraph 5, line 3. Insert "for" before "each". (edited text)
- Pg. 30 – Paragraph 5 refers to botany datasheet "below" but there isn't any in near proximity. I would delete all the directional references. *MK: Most have been deleted except were appropriate to leave in.*
- Pg. 32 – Paragraph 1. I found this paragraph confusing, especially the last sentence. What data are recorded for each reach and transect where observers can't collect data? (edited text)
- Pg. 32 – Buffer Condition. Replace "are" with "of". (edited text)
- Pg. 34 – Last paragraph. There is no closing parenthesis and Appendix A is referenced within another reference to Appendix A. Confusing. (edited text)
- Pg. 35 – Section 2.6.3, line 3. Replace "and" before "estimate" with "an". (edited text)
- Pg. 35 – Plant Layers and Dominant Plants: Quercus not italized. *MK: fixed.*
- Pg. 41 and 42. Datasheets are not referenced by their figure numbers. *MK: datasheets now referenced.*
- Pg. 52 – Section 4.3.1, line 1. Replace "staff has" with "staff have". (edited text)
- Pg. 52 – Paragraph 4, line 1. Replace "is" after reach with "are". The noun is coordinates. (edited text)
- Pg. 54 and 56 – More species not italicized. *MK: fixed*
- Pg. 65 – 6.2.2, line 1. Replace "staff has" with "staff have". (edited text)
- Pg. SOP 5.4. Juncus balticus not italicized. *MK: fixed*
- Pg. SOP 5.6, b. What is "a m"? (edited text)
- Pg. SOP 5.6, c. I found this description of cover very confusing. Can you simplify? (Edited text on page 5.6 part c to clarify)

- Pg SOP 5.6, last paragraph. Refers to relative cover. I though absolute cover was collected. Did I misinterpret this? Do you mean relative percentage area of the width zones? (edited text)
- Pg. SOP 5.15, Indicators of Active Aggradation. #3 – typo. (edited text)
- Pg. SOP 5.23, Data Collection, Including Photodocumentation. I thought images were removed from the protocol. (yes, photomonitoring was removed from the protocol due to reviewer concern. However, use of photography as a tool was not removed from the protocol. The purpose of the photodocumentation here is not to detect change over time, i.e., "photomonitoring", but to assist with re-locating the site in the future)
- Pg. SOP 7.1. The SOP starts on a left-hand page instead of a right-hand page. *MK: fixed*

SOP 2. Personnel Safety

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
-	September 2009	Denn, M.		-	1.0

Job Hazard Analysis

Field personnel should have personal protective equipment at all times for work in the hot and arid summer landscape and brushy stream corridors of Pinnacles National Monument. This includes hats, sunglasses, sun screen, water bottles, boots, and protective clothing. Poison oak is a considerable hazard at the monument; personnel should be able to recognize poison oak in all life forms, wear long-sleeved shirts and long pants, change clothing shortly after field work, and wash frequently with soap designed to minimize poison oak rash (*e.g.*, Tecnu).

Job Hazard Analysis

PINN Riparian and Associated Wetland Monitoring

U.S. Department of Interior National Park Service	WORK PROJECT/ACTIVITY Riparian Habitat and Wetland Monitoring	LOCATION Pinnacles National Monument	UNIT Nat'l Resource Mngt and Science
JOB HAZARD ANALYSIS (JHA)	DEVELOPED BY Marie Denn (NPS Pacific West Region) adapted from GOGA Fish Monitoring JHA	JOB TITLE Aquatic Ecologist	DATE PREPARED September 2009

APPROVED BY: DATE:

Required and/or Recommended Personal Protective Equipment

Sturdy work boots

Warm clothing / hat

Loose-woven natural fiber long-sleeve shirt

Sun hat

Polarized sunglasses

Cotton gloves / wool gloves

Sunscreen

Personal water bottles

First Aid Kit

Park radio

Tecnu (poison oak cleanser)

Maps

Forceps / vial (for tick removal and preservation)

Tasks/Procedures	Hazards	Abatement Actions Engineering Controls Substitution Administrative Controls Personal Protection Equipment
All Tasks and Procedures	Unfamiliarity	All people (permanent, seasonal, VIPs) involved in any project should receive a general orientation and tailgate safety session specific to the task prior to beginning of work.
1. Driving to and from remote field sites.	Wear seatbelts at all times when vehicle is moving!	
	1a. Narrow, single-lane roads with bumpy or “washboard” surfaces.	Maintain a safe speed (this if often below the legal speed limit) for the road conditions. Stay clear to the right, especially on curves. Drive with headlights on at all times. When turning around on mountain roads always “face the danger” (versus backing toward the cliff edge). When backing up, the passenger should get out and spot for driver.
	1b. Driving with limited visibility;	Maintain windshield cleaner fluid level and clean both sides of windows regularly (remember back window). Slow down. If blinded by sun or dust, proceed slowly or pullover and wait for hazard to pass. Keep to the right hand side of the road and drive with your lights on.
	1c. Sharp rocks on edge or in middle of road;	Make sure tires are properly inflated and check tread and walls regularly for damage. Make sure tire jack fits the vehicle and all parts are in the vehicle. Reduce speed substantially in places with large amounts of rockfall. If you encounter sharp rocks, get out and move them out of the way.
	1d. Large animals crossing or standing in roads	Slow down where animals might be present to allow for reaction time. Do not swerve abruptly to avoid hitting an animal; if necessary it’s better to ride out the impact.
	1e. Fatigue at night and after a long shift	Be aware of signs of fatigue- pull over and rest

	in the field;	If fatigued: Take a short catnap. Eat a snack Have a partner drive; do not take chances by continuing to drive. Communicate with your field partner.
	1f. Storm conditions – wind, lightning, muddy/ slippery roads;	Keep informed on the current weather; check www.weather.com or www.wrh.noaa.gov If winds exceed 15 mph, or the excessive wind category on Beaufort scale (tree tops swaying, twigs and leaves falling, *etc.*), do not travel into the field. If lightning is present, avoid going to the field and avoid using radios. When roads are muddy and slippery or snow covered, drive slowly. If you are uncertain of back road conditions, check with geologists. Avoid wet clay roads as much as possible. These roads can fail after storms, especially in spring. Maintain a slow speed when driving on these roads! If you damage waterbars make sure you repair them immediately.
	1g. Fallen trees on road;	For small trees, try and remove tree or cut with a handsaw and remove portion of tree. For large trees, notify support crew to remove tree.
	1h. Others driving on the road;	Do not assume you are the only one on the road behind locked gates (day or night); people from other agencies use these roads. Be alert to the idea that others may be coming in from the field in the early a.m. Drive slowly and keep right. If you encounter an unusual situation, contact your partner to inform and notify the supervisor or park ranger. Avoid confrontational situations with visitors; let the rangers handle issues with visitors.
2. Communication	2a. Unable to reach a radio repeater in a remote location.	Make sure radio is charged. Try to raise someone on the radio to inform them of your predicament. If you are unable to reach a repeater from your location, climb up a slope toward a ridgetop or knoll and try again. Try at regular intervals, just meandering around may help in getting a signal. Use cell phone in vehicle (if available), as this may be more reliable

		for communication in remote locations. However, most of Pinnacles NM does not receive cell phone reception.
3. Hiking in and alongside streams, and on monument trails	3a. Steep, rugged, and slippery terrain	Assess terrain conditions to find safe route and modify sampling plans to avoid unsafe areas. Proper footwear is very important; wear boots with Vibram or other slip-resistant soles with tops well above the ankle, broken in before the field season, plus 2-3 pairs of cotton or wool socks. No tennis shoes! If wearing wading boots be cognizant that they are slippery on grass and mud. Carry supplies in backpack. Make sure pack is comfortable and secure; using a pack with a waist belt recommended. Take care when walking on leaf litter, pine needles, dead grass, bedrock, and on wet ground. Maintain an erect posture when contouring steep slopes; avoid walking below another person due to the potential for rocks to dislodge from above. Use caution when crossing large and/or wet logs.
	3b. Undergrowth	Wear safety glasses (or other glasses) when hiking in brushy areas to protect eyes from protruding objects.
4. Encountering animals, disease, people, and noxious plants	4a. Poison oak	Make sure you can identify poison oak in all its growth forms: foliage bare twigs (the plant is toxic in winter when foliage is absent) berries Apply barrier cream to prevent exposure; wear long sleeves (or comparable). Avoid sitting with arms resting on knees. Use Tecnu (or something similar) lotion to prevent exposure. Wash with Tecnu soap immediately after returning from the field. Bring an extra set of clothes and shoes to change into after coming out of field. Wash field clothes separately from other laundry.
	4b. Bees/Wasps/Hornets	Determine if any field crew are allergic to bee stings. Notify other crew members and the supervisor if you know you are allergic to bee stings. Ensure that individual who is allergic carries prescribed medication to prevent anaphylactic shock.

	Carry a bee sting kit or Benadryl or other antihistamine. Be aware of the ground where you step; some hornets build nests in the ground at the base of trees or shrubs, or in rotten logs. Watch for bees buzzing in and out of holes or around ground level.
4c. Ticks	Know how to identify and distinguish the “red legged tick” that carries Lyme disease. If bitten by a tick, remove it (grasp tick with tweezers at head and pull straight out), and follow instructions for preserving it and turn it in to the county health department so staff can determine if it was carrying Lyme. Fill out a CA-1 (accident report) in the event that symptoms of Lyme disease appear eventually.
4d. Scorpions and black widow spiders	Inspect items left lying on the ground, *e.g.,* clothing, for scorpions and spiders prior to putting them on. Avoid placing hands around or under objects where you cannot see if a scorpion or spider is present Take care in selecting places to sit. If sitting on open ground, pick an area where a spider hole will be evident. Spiders may also live under rocks in dry stream beds and banks. Check spider webs in the vicinity of fieldwork and exercise extra caution in areas with strong webs (black widow webs are unusually strong).
4e. Rattlesnakes	Avoid rattlesnakes by inspecting the ground near logs before stepping over them. Avoid placing hands on rock ledges or other natural hoists without visually inspecting them first. In the unlikely event you’re bitten by a rattlesnake: Stay calm. Sit still. Call for help. Wait for help.

	4g. Mountain lions	Avoid mountain lions. If you encounter a lion that doesn't run from you, leave the area. If you encounter a lion that does not leave the area: Maintain eye contact with the lion while carefully backing away from it. Make yourself appear as large as possible by opening a coat or backpack over your head. Do not crouch or do anything to make yourself appear smaller. If attacked, fight back.
	4h. Disease (bubonic plague, rabies, and Hanta Virus)	Stay away from dead rodents and rodent feces, especially in closed buildings. Do not touch sick or dead bats. Do not approach or touch any animal that appears tame or exhibits unusual behavior.
	4i. Encounters with strangers	Report uncomfortable encounters with strangers in the park to a supervisor as soon as possible. Report apparent dangerous illegal activity to a park ranger, do not get into a confrontation with visitors in the park.
5. Exposure to environmental variables	5a. Treatment of general injuries	All NPS field staff and contractors will be required to have first aid training.
	5b. Hypothermia	Always anticipate bad weather and dress accordingly, or carry warm clothes with you. Always travel in pairs (as a minimum). Keep clothing as dry as possible. Eat high energy nutritional supplements between meals. Cover the head and neck to prevent heat loss. Keep active to maintain the body's metabolism. Drink plenty of liquids to prevent dehydration, although an individual with dehydration does not "feel" thirsty. Drink warm liquids not cold. Understand the effects of cold and wind; most cases of hypothermia develop at temperatures between 30°F and 50°F.

	5c. Hyperthermia	Hyperthermia may occur during high temperatures. Monitor team members for: dehydration heat exhaustion heat cramps heat stroke Monitor for symptoms including: nausea headache flushed, red skin Drink plenty of water (even when you are not thirsty). Wear a light-colored shirt. As heat increases, take frequent breaks in cool locations.
	5d. Giardia	Giardia is caused by drinking contaminated water. Carry plenty of water on outings. Consider all streams contaminated.
	5e. Sunburn	Much of the work takes place in full sunlight so prevent sunburn. Use 15+ or greater SFP sunscreen and lip balm. Wear a hat, sunglasses, and shirt.
6. General work in or near streams	6a. Working near unstable, steep, deep channels, swift flows.	Familiarize yourself with work area prior to fieldwork: Review maps and aerial photos to determine access points, reference points, and potential evacuation points. Know the current and projected flow conditions from weather forecasts and stream gauge info. Reconnoiter to familiarize yourself with stream and reach adjacent to project. Develop evacuation plans for remote stream sites. Make sure you sign out (including location) on the checkout board prior to leaving for the field.
	6b. Giardia	Refer to 5d.
	6c. Sunburn	Refer to 5e.
	6d. Undergrowth	Refer to 3b.

7. Riparian surveys	7a. Wading/walking in and across streams	Wear proper footwear for conditions. Use walking stick to improve stability in current. Walk slowly and carefully. Work in teams of two or more and within sight of one another. Cross-stream at shallow riffles, and avoid deep, swift areas. Consult weather forecast each morning or call local observer to determine stream and flow conditions. Avoid wet logs and slippery rocks. Sign out/in at board in front office each day. Carry a means of communication (*e.g.,* cell phone or radio).
	7b. Wading/walking in and across aquatic sites	Refer to 7a. When wading in aquatic sites with deep, fine sediments, test sediment depths with wading rod before entering. Do not enter when fine sediment depths extend above knee.
	7c. Crossing Debris Jams	Determine the safest route along the creek, either by climbing around on either side of the banks, or by going under and/or on top of the jam. When crossing you should be in sight of your coworkers in case anything should occur.
	7d. Hypothermia	Refer to 5b.
	7e. Giardia	Refer to 5d.
	7f. Sunburn	Refer to 5e.

JHA Instructions

The JHA shall identify the location of the work project or activity, the name of employee(s) involved in the process, the date(s) of acknowledgment, and the name of the appropriate supervisor approving the JHA. The supervisor acknowledges that employees have read and understand the contents, have received the required training, and are qualified to perform the work project or activity.

Identify all tasks and procedures associated with the work project or activity that have potential to cause injury or illness to personnel and damage to property or material. Include emergency evacuation procedures (EEP).

Emergency Evacuation Instructions

Work supervisors and crewmembers are responsible for developing and discussing field emergency evacuation procedures (EEP) and alternatives in the event a person(s) becomes seriously ill or injured at the worksite.

Be prepared to provide the following information:

Nature of the accident or injury (avoid using victim's name).
Type of assistance needed, if any (ground, air, or water evacuation).
Location of accident or injury, best access route into the worksite (road name/number), identifiable ground/air landmarks.
Radio frequencies.
Contact person.

Identify all known or suspect hazards associated with each respective task/procedure listed. For example:
a. Research past accidents/incidents.
b. Research the Health and Safety Code, or other appropriate literature.
c. Discuss the work project/activity with participants.
d. Observe the work project/activity.
e. A combination of the above.

Identify appropriate actions to reduce or eliminate the hazards identified. Abatement measures listed below are in the order of the preferred abatement method:

a. Engineering Controls (the most desirable method of abatement). For example, ergonomically designed tools, equipment, and furniture.

b. Substitution. For example, switching to high flash point, non-toxic solvents.
Work Leader

c. Administrative Controls. For example, limiting exposure by reducing the work schedule; establishing appropriate procedures and practices.

d. PPE (least desirable method of abatement). For example, using hearing protection when working with or close to portable machines (chain saws, rock drills, and portable water pumps).

e. A combination of the above.

Copy of the JHA as justification for purchase orders when procuring PPE.

Local hazards to ground vehicles or aviation.
Weather conditions (wind speed & direction, visibility, temperature).
Topography.
Number of individuals to be transported.
Estimated weight of individuals for air/water evacuation.

The items listed above serve only as guidelines for the development of emergency evacuation procedures.

JHA and Emergency Evacuation Procedures Acknowledgment
We, the undersigned work leader and crewmembers, acknowledge participation in the development of this JHA (as applicable) and accompanying emergency evacuation procedures. We have thoroughly discussed and understand the provisions of each of these documents:

SIGNATURE DATE

SOP 3. Equipment and Supplies

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
-	September 2009	Denn, M.	-	-	1.0

Figures

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Field Equipment and Supplies

- Botany clipboard with reference information and blank datasheets. The Botany clipboard will include blank Botany and Plant Species List Datasheets (some printed on write-in-the-rain paper) (see section 3.2 of the Protocol Narrative), key to vegetation communities (see SOP 9), and list of wetland plant species (see SOP 9).
- Reach Condition clipboard with reference information and blank datasheets. The Reach Condition clipboard will include blank Reach Condition datasheets (some printed on write-in-the rain paper) (see section 3.2 of the Protocol Narrative), sheets with criteria for scoring CRAM-derived metrics (see SOP 5), and sheets for identifying Rosgen stream types (see SOP 9)
- 7.5-minute quadrangles of the park. Observers will need four 7.5-minute quadrangle maps for Pinnacles National Monument: Bickmore Canyon, North Chalone Peak, San Benito, and Topo Valley. These are available from the US Geological Survey and from the San Francisco Bay Area Network's Geographic Information System data store.
- 100-meter tape and 25-meter tape. The 100-meter tape will be used for measuring stream reaches, the 25-meter tape will be used for data collection on cross-channel transects. These are available at forestry and biological supply outfitters.
- Chain pins - 3 of these flagged with "1" "2" and "3" - and carry pouch. Chain pins will be used to secure the ends of the 100-meter and 25-meter tapes. In addition, the marked chain pins will be carried by the hydrogeomorphology technician as he/she paces up each 100-meter reach (see SOP 5) and placed at 25-meter intervals. The botany technician, following, will use the markers to estimate foliar cover of dominant plant species, wetland abundance, and non-native grass community abundance, while retrieving the pins. Chain pins are available at forestry and biological supply outfitters. See Figure SOP 3.1.
- Point sampling device (see Figures SOP 3.2 and 3.3). This device will be used to sample 20 to 30 points along the cross-channel transects (see SOP 5). The pointing and leveling device are custom-fabricated devices from:

  Technical Consultants, Inc.

  Wayne Fanslow

  40950 SE Clausen Road

  Estacada, OR 97023

  This device is attached to a 1-meter sectional survey rod acquired from Stakemill Online Survey Suppliers under the name "CST Duralast Metric Range Poles 2m 2 Section". The survey pole is graduated with a permanent marker with 0.25-meter increments, for use in estimating water depth. At the beginning of each field season the project technicians may need to reinforce the markings if they have faded.
- Field backpack capable of carrying point sampling device. The field backpack should have side pockets for insertion of the long (1-meter) sections of the point sampling
- Gravelometer. This metal sheet is used for consistent measurement of gravel, cobble, and rock in streambeds (see SOP 5). The device is available at forestry and biological supply outfitters under the name "Al-Sci Field Sieve/Gravelometer". See Figure SOP 3.1.

- Densitometer. This optical siting device is used to sample the tree/shrub canopy at 20 to 30 overhead points along each cross-channel transect (see SOP 5). The device is available at forestry and biological supply outfitters under the name "GRS Densitometer". See Figure SOP 3.1.
- Compass. The compass is used for orienting transects perpendicular to the channel (see SOP 5).
- Multitool. The multitool (*e.g.,* Leatherman) is used for assembling and disassembling the point sampling tool before and after its use (so that it can be carried upstream easily).
- Calculator with random-number generator. During the first field season field technicians will site a cross-channel transect within every third 100-meter reach. The position of the transect within the reach will be determined via random number generation (see SOP 5). As an alternative to a calculator, field observers may carry a random-number table as found in Elzinga *et al.* (1998).
- Rangefinder and batteries. The rangefinder is used to measure distances across channels - from bankfull to bankfull (see SOP 5). These devices are available at forestry and biological supply outfitters; this project currently uses the following device: "Sonin Combo Pro with Electronic Target Unit" which requires two 9-volt batteries. This unit may be acceptably replaced (if necessary) with any similar device with comparable accuracy and resolution: Accuracy (at sea level and 53% RH): 99.85% in still air at 0° to 40°C, 99% at 5-10 mph wind, 98% at 10-20 mph wind; Resolution: 1 cm. See Figure SOP 3.1.
- Digital camera and batteries. The digital camera for documenting reach condition and transect location should be capable of adjusting aperture and shutter, so that field technicians may minimize aperture size (for greatest depth of field), and have a sensor size of at least eight megapixels (or best available technology).
- GPS unit: Trimble Geo XH and beacon or comparably accurate technology. Field observers should carry a GPS unit with sub-meter accuracy for establishing and re-locating cross-channel transects, and also for determining the end-points of the channels to be evaluated (endpoints being defined by monument boundaries or watershed size). This unit should be available for use from either the network or park. Field staff will use a dedicated charging unit to charge batteries.
- Hand lens. Approximately 10X magnification, for use by the botany technician for plant identification; available at forestry and biological supply outfitters.
- Pair small clippers. Small hand clippers will allow field technicians to minimally prune dead riparian vegetation (when permitted by park managers) to allow safe travel in stream corridors. In cases where more than minimal pruning would be necessary to allow travel technicians will either walk alongside the channel to pace and collect data, or will forego data collection for that reach due to undue hazard.
- Park radio for emergency communication. Field technicians will carry a park radio at all times in the field, and monitor park radio traffic for alerts which may impact their ability to work safely in remote areas of the park (see SOP 2). The radio will be on-loan from the park for the duration of the field season; park staff will train field technicians on its appropriate use. Field staff will use a dedicated charging unit to charge batteries.

- Plastic bags for collection of unknown plant specimens. If permitted, the botany technician may collect small samples of park vegetation for office-based species identification.

Figure SOP 3.1. Gravelometer (top); Rangefinder (bottom left); Densitometer (bottom center); Chain pins and carry pouch (bottom right).

Figure SOP 3.2. Point sampling device.

Figure SOP 3.3. Point sampling device detail.

Office Equipment and Supplies

In addition to the field equipment listed above, field technicians will need access to the following office-based equipment and supplies:

- Laptop or desktop computers for data-entry. Computers will be made available by either the park or the network for limited periods during each week. Computers should be loaded with Microsoft software programs Word, Excel, and Access.
- Dissecting microscope to aid office-based plant identification. The botany field technician will make use of park or network equipment.
- Copy machine for fabricating datasheets and duplicate reference sheets when necessary.
- Write-in-the-rain paper. Although rain in summer is very rare at Pinnacles NM, each field clipboard should include a set of datasheets duplicated on waterproof paper.
- Blank data-storage media, such as Compact Disks (CDs) or Digital Versatile Disc (DVDs), for backing-up and transferring data during the field season.

Personal Protective and Safety Equipment

Furthermore, field technicians should always carry personal protective gear in the field, as identified in SOP 2.

Literature Cited

Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Measuring and monitoring plant populations. US Department of Interior, Bureau of Land Management Technical Reference 1730-01, Denver, Colorado. 492 pp. Online. (www.blm.gov/nstc/library/pdf/MeasAndMon.pdf.) Accessed 1 March 2010.

SOP 4. Data Management and Quality Assurance

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
-	September 2009	Press, D.	-	-	1.0

Figures and Appendixes

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Introduction

Two critical long-term goals of the San Francisco Bay Area Network (SFAN) Inventory and Monitoring Program (I&M) are to:

Integrate natural resource inventory and monitoring information into National Park Service (NPS) planning, management, and decision making

Share NPS accomplishments and information with other natural resource organizations and form partnerships for attaining common goals and objectives

In order for the Pinnacles National Monument (PINN) wetland monitoring protocol to meet I&M Program goals, a detailed management plan is needed to ensure data quality, interpretability, security, longevity and availability.

This SOP describes how the monitoring protocol meets these data management objectives through database design, quality assurance and control measures, metadata development, data maintenance, data storage, and data archiving. Procedures for data handling and quality assurance/quality control for all monitoring protocols implemented by the SFAN monitoring program are detailed in the program's Data Management Plan (Press 2005) and in the National I&M Program's Data Management Plan (NPS 2008).

Database Design

Database Model Overview

The SFAN staff has developed a relational Microsoft (MS) Access XP database for the SNPL monitoring program at PINN compliant with the Natural Resource Database Template (NRDT) Version 3.2, an application developed by the National Park Service's Natural Resource I&M Program. The data in the wetland database are simply organized around survey events of defined 100-m reaches along select creeks within PINN. The survey or event data are related to wetlands found within the stream reach, the absolute cover of dominant plant species within the reach, vegetation data along a permanent transect within the stream reach, and the list of field staff present on the survey. Table relationships are displayed in Figure SOP 4.1 and a complete data dictionary is included as Appendix SOP 4 A.

The SFAN I&M staff are in the process of developing a separate front-end (user interface) that connects to the back-end data tables. The user interface for the database will be modeled after the NRDT Front-end Application Builder (FAB) Version 1.0, an MS Access user-interface template designed by the NPS Natural Resource GIS Program.

Table Structure

The primary wetland monitoring events table, tbl_Events, is linked to tbl_Event_Details in a one-to-one relationship via an Event_ID Globally Unique Identifier (GUID) (Figure SOP 4.1).

Whereas, tbl_Events simply stores event location, date, and time values, tbl_Event_Details stores data values specific to the 100-m stream reach surveyed during the monitoring events. Data fields describing the streambed, stream bank, habitat, and vegetation characteristics – all of which are recorded once within the stream reach – are stored in tbl_Event_Details.

Tbl_Events is linked to seven tables by one-to-many relationships (Figure SOP 4.1):

tbl_Transect_Data – Stores data regarding plant species and substrate collected along a permanent transect within the stream reach.

tbl_Wetlands_Present – Stores data regarding wetland types present within four 25-m segments of the 100-m stream reach.

tbl_Dominant_Plants – Stores data regarding dominant plant species and associated absolute percent cover within the stream reach.

tbl_Early_Detection – Stores data regarding the presence of top-priority invasive plant species and associated absolute percent cover within the stream reach.

tbl_Wildlife – Stores data regarding wildlife species observed that are on the PINN wildlife watch list.

tbl_Data_History – Records any data verification, data certification, or editing procedures associated with the monitoring event and related data.

xref_Event_Contacts – A cross-reference table linked to tlu_Contacts which documents the field personnel that collected the wetlands monitoring data.

The geographic coordinates of the downstream starting point of each 100-m stream reach is collected in the field by GPS and entered as XY coordinates within tbl_Events. Due to changes in channel morphology over time, it is critical that GPS data are collected each time a stream reach is surveyed during the course of this monitoring protocol. Because the stream reach starting point may vary over time, it is not appropriate to store stream reach spatial data in a separate locations table, as is typical with other databases designed with the NRDT.

Spatial data relating to permanent transects established within the 100-m stream sections is stored in tbl_Transect_Locations. Each transect is assigned a unique Transect_ID value, which provides a link to tbl_Events. The transect locations table is adopted from the NRDT's locations table.

The NRDT provides a location aggregations table, tbl_Sites, that helps to group locations by common geographic placement. In this case, the stream itself is the common geographic feature that can be used to group the permanent transects and 100-m stream reaches. Each stream name stored in tbl_Sites is assigned a unique Site_ID value, which provides a link to tbl_Events and tbl_Transect_Locations.

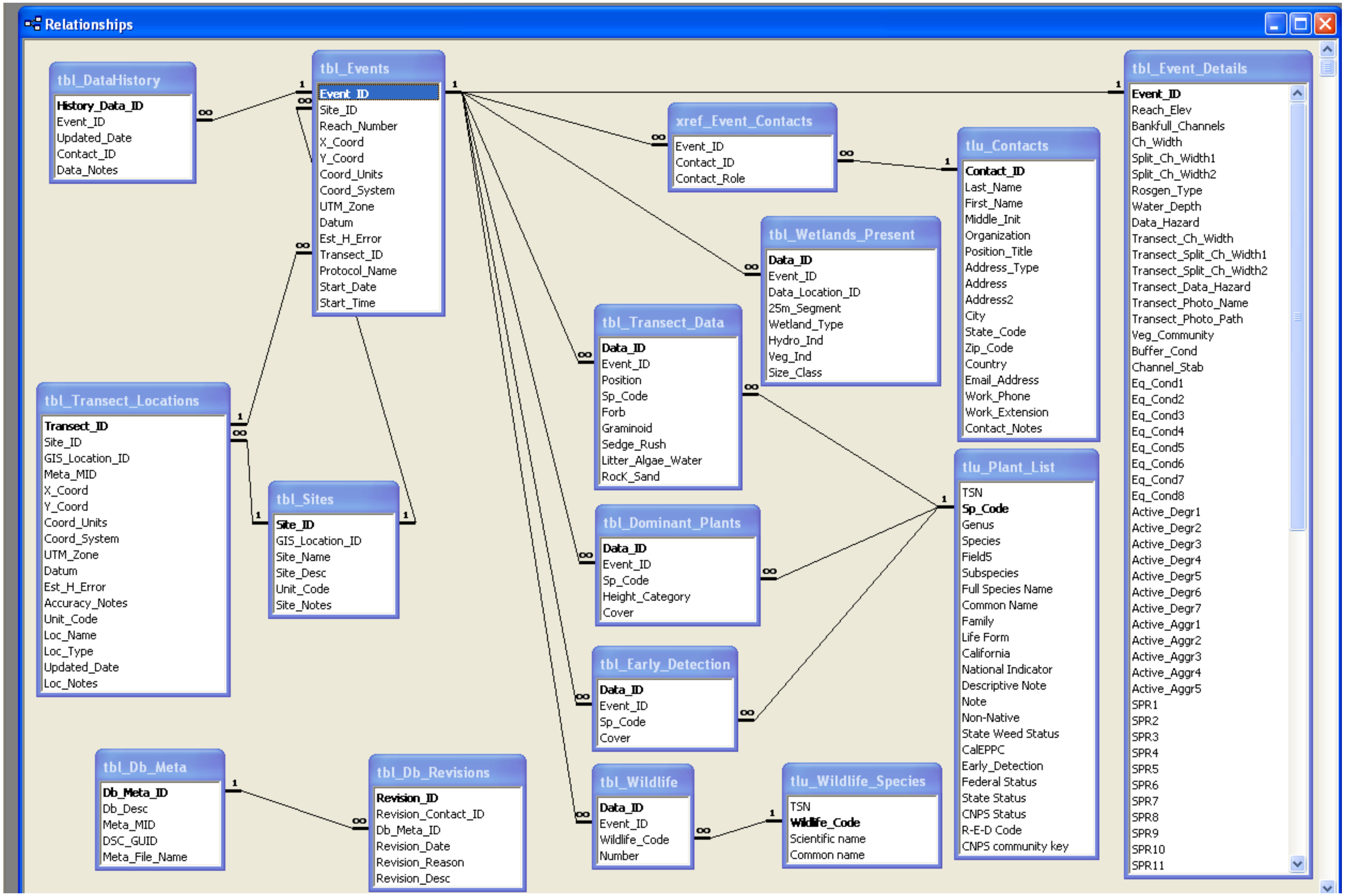

Figure SOP 4.1. Table relationships in the Pinnacles National Monument wetlands monitoring Microsoft Access database, PINN_Wetlands_NRDT.

Data Work Flow

During each monitoring season, data are entered by the field staff directly into the master PINN wetland monitoring database. Data entry should occur as soon as possible following data collection in the field. The SFAN Data Manager will ensure that field staff are properly trained in using Microsoft Access and in navigating the wetlands database prior to data entry. The database is provided in MS Access XP format.

The database should be backed up regularly during the course of the monitoring season and data entry. CDs are a good option for back-ups. Databases can be also be regularly copied to an archive on the network, to a hard drive, or both. File names of back-up databases should include the date and time of the back-up, such as:
PINN_Wetlands_v1_00_20090819_1035.

At the end of each season, the field staff is responsible for proofing the data entry records in the database against field notes and paper datasheets completed during the surveys. When complete, the database is sent or provided to the SFAN Data Manager for additional review and certification. The Data Manager works with the Principal Investigator / Project Coordinator and the field staff to complete any final edits or additions to the new monitoring dataset. Final steps include documentation in the database history log and an update to the database metadata record.

Quality Assurance and Quality Control

The success of the wetland monitoring protocol is dependent on the quality of the data it collects, manages, and disseminates. Analyses performed to detect ecological trends or patterns require data that are recorded properly and have acceptable precision, accuracy, and minimal bias. Poor-quality data can limit detection of subtle changes in ecosystem patterns and processes, can lead to incorrect interpretations and conclusions, and can greatly compromise the credibility of the program managing it.

Quality assurance (QA) can be defined as an integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the consumer. Quality control (QC) is a system of technical activities that measure the attributes and performance of a process, item, or service relative to defined standards (Palmer 2003). While QA procedures maintain quality throughout all stages of data development, QC procedures monitor or evaluate the resulting data products.

To ensure that the wetland monitoring protocol produces and maintains data of the highest possible quality, QA/QC procedures are implemented to identify and minimize errors at each data project stage.

Data Collection

Attention to detail during the data collection phase is crucial to overall data quality. Unlike a typographical error that occurs during data entry, an incorrect observation in the field is not easily corrected. The wetland monitoring protocol adopts the following guidelines regarding data collection that affect data quality:

- Field crews will receive proper training in data collection and recording.
- Field equipment will be regularly maintained and calibrated.
- Data will be recorded on pre-formatted, project-specific datasheets that reflect the overall design of the project and are designed to minimize the amount of writing necessary to effectively record observations.
- The format of field datasheets will be reflected in the computer data entry interface to help ensure all relevant information is recorded and subsequent data entry errors are minimized.
- Field forms will be reviewed for completion and errors each day in the field.

Data Entry

Data entry is the process whereby the raw data collected in the field are transferred from paper field forms and notes into the project databases. The field staff performs all data entry into the project database. The goal of data entry is to transcribe field observations into the database with 100% accuracy, although errors are unavoidable. Several QA/QC practices help to reduce errors during the data entry phase:

- Data will be entered as soon as reasonably possible after collection
- Data entry will be completed by the field staff that collected the data.
- The Principal Investigator / Project Coordinator or SFAN Data Manager must ensure that the field staff is familiar with the database software, database structure, and any standard codes in the databases. At a minimum, data entry technicians should know how to open a data entry form, create a new record, edit an existing record, and exit the database properly. They must also learn how to correct mistakes made while typing.
- Data will be entered into pre-designed database forms that resemble field sheets to the greatest extent possible. Data entry forms maximize error control wherever possible, include the use of default values, limiting data entry domains to values in drop-down menus, and auto-generating certain codes.
- Data will be entered, one logical "set" at a time. Paper forms are initialed and dated when completed to avoid confusion about what has been entered and what has not.

Data Verification

Following data entry, subsequent data verification is conducted to ensure that the raw data on the paper datasheets matches the entered data. The following steps occur during the data verification phase:

- Data verification is carried out by the field staff that collected the data.

- A visual review after data entry is performed with one person reading aloud from the original datasheets while a second person checks the corresponding data in the database.
- Errors in the data are immediately corrected once discovered.
- When complete, a verification record is added to the data history table in the database and the paper datasheet is initialed and dated.
- All records (100%) are verified against the original source data.
- A subset of randomly selected records (10%) is reviewed after initial verification by the SFAN Data Manager. If significant errors are found, the entire data set should be verified again by the project field staff.

Data Validation

Data verification checks that the digitized data match the source data, while data validation checks that the data make sense. Although data entry and verification can be handled by personnel who are less familiar with the data, validation requires in-depth knowledge about the data. The SFAN Data Manager performs all data validation procedures on a new set of monitoring data before certifying the data in the master databases. The Data Manager consults with the Project Coordinator, the field staff, or directly reviews the datasheets to correct any errors that are discovered.

During the data validation phase, the Data Manager checks all the satellite databases for the following and makes corrections as needed:

- Verification records for all survey data records.
- Erroneously generated records with no actual data.
- Orphaned records within the sub-tables (*i.e.*, no link back to tbl_Events).
- Data outliers – applies to both numerical and date/time values.
- Logic errors (*i.e.,* forb entered as very tall dominant plant).
- Correct values for fields with fixed domains (*i.e.,* wetland type, plant species code).
- Complete data entry for all required fields.

Version Control Guidelines and Database History

Version control guidelines for the PINN wetland monitoring database will follow those presented in the SFAN's Data Management Plan (Press 2005). Prior to any major changes to the database design, a back-up copy of the database should be made. Once the database design changes are complete, the database should be assigned the next incremental version number. The final copy of the previous database version should be archived with the version closing date incorporated into the database title. Version numbers should increase incrementally by hundredths (*e.g.,* version 1_01, version 1_02, *etc.*) for minor changes. Major revisions should be designated with the next whole number (*e.g.*, version 2_0, 3_0, 4_0 …). With proper controls and communication, versioning ensures that only the most current database version is used for queries and analyses. Significant database re-design may require approval by the Project Coordinator, review by other data management staff, and revisions to this data management

SOP. The database version number should be included in the file title of the database, for example, PINN_Wetlands_v1_00.

Elements within the wetland monitoring database help to document database metadata, release and revision history. First, the database retains two tables (tbl_Db_Meta and tbl_Db_Revisions) from the NRDT Version 3.2 for capturing metadata (Figure 1) that are maintained by the SFAN Data Manager. The table tbl_Db_Meta is designed to facilitate metadata creation and integration with I&M metadata systems. The field Db_Meta_ID is the primary key for tbl_Db_Meta and provides the link to revision history records in tbl_Db_Revisions. The Db_Desc field is a memo field for describing the purpose of the database application. When metadata for the NRDT database is uploaded to the NPS Data Store, the Meta_MID field stores the metadata master ID generated upon upload. When metadata for the database is created using the I&M Dataset Catalog desktop metadata application, the globally unique record ID generated by the Dataset Catalog should be copied to the DSC_GUID field. The table tbl_Db_Revisions stores the application revision history. Linking tbl_Db_Revisions to tbl_Db_Meta using Db_Meta_ID facilitates accessing the revision history for inclusion in each metadata record.

The Data Manager maintains an additional history log of the wetland monitoring database in a Microsoft Word document titled PINN_Wetland_Database_Log located at:
Inpgogamahe1\Divisions\Network I&M\Individual Vital Signs\Wetlands\PINN\data

All design modifications to the database are logged in more detail within the history log and are referenced to changes in database version numbers. Design modifications include changes to the table structure, user interface, or underlying macros and Visual Basic Code. Major changes to the data themselves are also noted in this document, such as when a new set of monitoring data is certified. It is especially important to note edits to the data that will result in changes to final data summaries previously published in End of Year Reports or other media. This will prove invaluable to data users attempting to understand differences in data between years.

The database history may also be used each monitoring season to summarize anything that was unique or changed about the season's methodology and is therefore reflected in the dataset. Notes on techniques for collection and review of data are also very helpful.

Metadata Procedures

The NPS GIS Committee requires all NPS GIS data layers be described with the NPS Metadata Profile, which combines the FDGC standard, elements of the ESRI metadata profile, the Biological Data Profile, and NPS-specific elements. Although no standard has been applied to natural resource databases and spreadsheets, the SFAN will complete the NPS Metadata Profile to the greatest extent possible to document the PINN wetland monitoring database.

A complete metadata record for the wetland monitoring database will be generated in compliance with current NPS standards by the SFAN Data Manager. Because the location data for this project is stored as UTM coordinates within the MS Access databases, there are no spatial data products associated with this protocol that require metadata records.

The metadata records for the wetland monitoring database will initially be developed in Dataset Catalog v3.0, an MS Access metadata development and catalog tool developed by the NPS I&M Program. Dataset Catalog is currently the preferred tool to begin metadata records for MS Access databases because of its ability to harvest entity and attribute information from this database format.

The metadata records will be exported from Dataset Catalog as XML files and completed in NPS Metadata Tools and Editor v1.1 (NPS MTE), thus allowing for all NPS-specific elements in the metadata records to be completed. When completed, metadata records, but not the data themselves, will be posted to the NPS Data Store for public discovery and consumption. Contact information within the metadata records will direct interested parties to the SFAN Data Manager for further inquiries. Master database metadata records posted to the NPS Data Store will be updated after a new set of monitoring data has been entered and certified or following database revision to a new version whole number (*i.e.*, v1_3 to v2_0, but not v2_0 to v2_1).

The NPS Data Store can be accessed at: http://science.nature.nps.gov/nrdata/

Data Storage and Archival Procedures

Point Reyes National Seashore (PORE)

The Principal Investigator / Project Coordinator is stationed at Point Reyes National Seashore (PORE).

At PORE, digital data files are housed at:
Inppore05\Resources\Natural\PinnaclesRiparian

The following folders reside within the above directory:

- Wetland_Master_Database
  The master wetland monitoring database is stored here. The database format is Microsoft Access and the title is "PINN_Wetlands_NRDT" plus the version number, such as PINN_Wetlands_NRDT_v1_00.
  - Wetland_Master_BackUps
    Back-up copies of the active master databases should be stored here. File names of back-up databases should include the date and time of the back-up, such as: PINN_Wetlands_v1_00_20090819_1035.
  - Wetland_Dbase_Archives
    When the master database is converted to a new version number, the final previous database version should be archived here.

Golden Gate National Recreation Area (GOGA)

Copies of data files for the PINN wetland monitoring protocol are transferred to GOGA, where the SFAN I&M Program office and the SFAN Data Manager are stationed. The database is transferred to GOGA each time a new set of monitoring data is certified in the database or the database is converted to a new version number. The GOGA copy of the active master database is stored at: Inpgogamahe1\Divisions\Network I&M\Individual Vital Signs\Wetlands\data

Previous database copies or versions will be archived at GOGA at:
Inpgogamahe1\Divisions\Network I&M\IM_Archive\VS_Indicators\Wetlands\data

Pinnacles National Monument

Copies of data files for the PINN wetland monitoring protocol are transferred to PINN for use by PINN resource management and planning staff. The database is transferred to PINN each time a new set of monitoring data is certified in the database or the database is converted to a new version number. The PINN copy of the active master database is stored at:
Inppinn001\SharedData\RRM\RRM_Data\PinnaclesRiparian

Data Distribution

In order for the wetland monitoring protocol to inform park management and to share its information with other organizations and the general public, guidance documents, reports, and data must be easily discoverable and obtainable. The main mechanism for distribution of the monitoring documents and data will be the Internet. The wetland monitoring protocol, accompanying SOPs, and all End of Year Reports will be made available for download at the SFAN website: http://science.nature.nps.gov/im/units/sfan/

Although the wetland monitoring database will not be posted for public download, as previously mentioned, metadata records for the master database will be maintained at the NPS Data Store. The metadata records will direct interested parties to the SFAN Data Manager for further inquiries.

In addition to the NPS Data Store, the NPS I&M Program maintains an on-line natural resource bibliographic database known as NatureBib. NatureBib records will be created for all of the PINN wetland monitoring documents, including the protocol, End of Year Reports, and any resulting publications. The public version of NatureBib is in development by the NPS I&M program.

All documents produced by the wetland monitoring program will be published in either the Natural Resource Report Series or the Natural Resource Technical Report Series following guidance from the NPS Natural Resource Stewardship and Science in Fort Collins, CO. The Natural Resource Publications Management home page hosts a list of all documents published in the NRR and NRTR Series. The home page can be found at:
http://www.nature.nps.gov/publications/NRPM/

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Appendix SOP 4.11. Pinnacles National Monument Wetland Monitoring Database Data Dictionary.

Data Dictionary for: Pinnacles NM Wetland Monitoring Database

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TABLE NAME: **tbl_Events**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Stream reach sampling events.
FORMAT: Microsoft Access
NO. OF FIELDS: 14

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
Event_ID	dbText	50	Event identifier.
Site_ID	dbText	50	Site identifier.
Reach_Number	dbDouble	8	Stream reach number.
X_Coord	dbDouble	8	X coordinate.
Y_Coord	dbDouble	8	Y coordinate.
Coord_Units	dbText	50	Coordinate distance units.
Coord_System	dbText	50	Coordinate system.
UTM_Zone	dbText	50	UTM Zone.
Datum	dbText	50	Datum of mapping ellipsoid.
Est_H_Error	dbSingle	4	Estimated horizontal accuracy.
Transect_ID	dbText	50	Link to tbl_Transect_Locations.
Protocol_Name	dbText	100	The name or code of the protocol governing the event.
Start_Date	dbDate	8	Starting date for the event.
Start_Time	dbDate	8	Starting time for the event.

TABLE NAME: **tbl_Event_Details**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Sampling event details.
FORMAT: Microsoft Access
NO. OF FIELDS: 61

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
Event_ID	dbText	50	Event ID.
Reach_Elev	dbDouble	8	Reachpoint elevation.
Bankfull_Channels	dbDouble	8	Number of bankfull channels at reachpoint.
Ch_Width	dbDouble	8	Channel width at reachpoint.
Split_Ch_Width1	dbDouble	8	Channel width at reachpoint, split channel 1.
Split_Ch_Width2	dbDouble	8	Channel width at reachpoint, split channel 2.
Rosgen_Type	dbText	50	Stream channel rosgen type.
Data_Hazard	dbText	50	Hazard that resulted in no or limited data collection at reachpoint, if applicable.
Transect_Ch_Width	dbDouble	8	Channel width at transect.
Transect_Split_Ch_W1	dbDouble	8	Channel width at transect, split channel 1.
Transect_Split_Ch_W2	dbDouble	8	Channel width at transect, split channel 2.
Transect_Data_Hazard	dbText	50	Hazard that resulted in no or limited data collection at transect, if applicable.
Photo_Name	dbText	50	File name of photo taken along transect.
Photo_Path	dbText	50	File path where photo of transect is stored.
Veg_Community	dbText	50	Dominant vegetation community of reach.
Buffer_Cond	dbText	50	Buffer condition.
Channel_Stab	dbText	50	Channel stability.
Eq_Cond1	dbBoolean	1	Equilibrium condition 1.
Eq_Cond2	dbBoolean	1	Equilibrium condition 2.

Eq_Cond3	dbBoolean	1	Equilibrium condition 3.
Eq_Cond4	dbBoolean	1	Equilibrium condition 4.
Eq_Cond5	dbBoolean	1	Equilibrium condition 5.
Eq_Cond6	dbBoolean	1	Equilibrium condition 6.
Eq_Cond7	dbBoolean	1	Equilibrium condition 7.
Eq_Cond8	dbBoolean	1	Equilibrium condition 8.
Active_Degr1	dbBoolean	1	Active degradation 1.
Active_Degr2	dbBoolean	1	Active degradation 2.
Active_Degr3	dbBoolean	1	Active degradation 3.
Active_Degr4	dbBoolean	1	Active degradation 4.
Active_Degr5	dbBoolean	1	Active degradation 5.
Active_Degr6	dbBoolean	1	Active degradation 6.
Active_Degr7	dbBoolean	1	Active degradation 7.
Active_Aggr1	dbBoolean	1	Active aggradation 1.
Active_Aggr2	dbBoolean	1	Active aggradation 2.
Active_Aggr3	dbBoolean	1	Active aggradation 3.
Active_Aggr4	dbBoolean	1	Active aggradation 4.
Active_Aggr5	dbBoolean	1	Active aggradation 5.
SPR1	dbBoolean	1	Structural patch richness 1.
SPR2	dbBoolean	1	Structural patch richness 2.
SPR3	dbBoolean	1	Structural patch richness 3.
SPR4	dbBoolean	1	Structural patch richness 4.
SPR5	dbBoolean	1	Structural patch richness 5.
SPR6	dbBoolean	1	Structural patch richness 6.
SPR7	dbBoolean	1	Structural patch richness 7.
SPR8	dbBoolean	1	Structural patch richness 8.
SPR9	dbBoolean	1	Structural patch richness 9.
SPR10	dbBoolean	1	Structural patch richness 10.
SPR11	dbBoolean	1	Structural patch richness 11.
SPR12	dbBoolean	1	Structural patch richness 12.
SPR13	dbBoolean	1	Structural patch richness 13.
SPR14	dbBoolean	1	Structural patch richness 14.
SPR15	dbBoolean	1	Structural patch richness 15.
SPR16	dbBoolean	1	Structural patch richness 16.
Topo_Complex	dbText	50	Topographic complexity.
Hoz_Int_Zon	dbText	50	Horizontal interspersion and zonation.
Vertical_Bio	dbText	50	Vertical biotic structure.
VTDP_Cover	dbDouble	8	Estimated absolute cover of very tall dominant plants (>3m).
TDP_Cover	dbDouble	8	Estimated absolute cover of tall dominant plants (1.5-3m).
MDP_Cover	dbDouble	8	Estimated absolute cover of medium height dominant plants (0.75-1.5m).
SDP_Cover	dbDouble	8	Estimated absolute cover of short dominant plants (<0.75m).
Event_Notes	dbMemo	0	General notes on the event.

TABLE NAME: **tbl_Wetlands_Present**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Wetland types present within four 25-m segments of stream reach.
FORMAT: Microsoft Access
NO. OF FIELDS: 8

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
Wetland_Data_ID	dbText	50	Field data table row identifier.
Event_ID	dbText	50	Link to tbl_Events.
Data_Location_ID	dbText	50	Optional link to tbl_Data_Locations.

25m_Segment	dbDouble	8	25m segment ID along the reach (25, 50, 75, 100).
Wetland_Type	dbText	50	Wetland type present within the section.
Hydro_Ind	dbText	50	Hydrology indicator associated with the wetland.
Veg_Ind	dbText	50	Vegetation indicator associated with the wetland.
Size_Class	dbDouble	8	Size class of the wetland.

TABLE NAME: **tbl_Transect_Data**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Data regarding plant species and substrate collected along the stream reach
FORMAT: Microsoft Access
NO. OF FIELDS: 9

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
Transect_Data_ID	dbText	50	Field data table row identifier.
Event_ID	dbText	50	Link to tbl_Events.
Position	dbDouble	8	Position along transect in cm.
Sp_Code	dbText	50	Plant species code.
Forb	dbBoolean	1	Forb present, yes or no.
Graminoid	dbBoolean	1	Graminoid present, yes or no.
Sedge_Rush	dbBoolean	1	Sedge/rush present, yes or no.
Litter_Algae_Water	dbText	50	Litter, algal mat, or water present (L or A or W).
Rock_Sand	dbText	50	Sand or rock presence and size class (S or R2-R15).

TABLE NAME: **tbl_Dominant_Plants**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Dominant plant species encountered within stream reach.
FORMAT: Microsoft Access
NO. OF FIELDS: 5

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
DomPlant_Data_ID	dbText	50	Field data table row identifier.
Event_ID	dbText	50	Link to tbl_Events.
Sp_Code	dbText	50	Plant species code.
Height_Category	dbText	50	Height category of plant species (very tall, tall, medium, short).
Cover	dbDouble	8	Estimated absolute abundance.

TABLE NAME: **tbl_Early_Detection**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Top-priority invasive plant species encountered within stream reach
FORMAT: Microsoft Access
NO. OF FIELDS: 4

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
ED_Data_ID	dbText	50	Field data table row identifier.
Event_ID	dbText	50	Link to tbl_Events.
Sp_Code	dbText	50	Plant species code.
Cover	dbDouble	8	Estimated absolute abundance.

TABLE NAME: **tbl_Wildlife**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Watch list wildlife species encountered within stream reach.
FORMAT: Microsoft Access
NO. OF FIELDS: 4

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
Wildlife_Data_ID	dbText	50	Field data table row identifier.
Event_ID	dbText	50	Link to tbl_Events.
Wildlife_Code	dbText	50	Wildlife watch-list species code.
Number	dbDouble	8	Number observed.

TABLE NAME: **tbl_DataHistory**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Details of data verification and editing of survey event records.
FORMAT: Microsoft Access
NO. OF FIELDS: 5

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
History_Data_ID	dbLong	4	Data history record ID.
Event_ID	dbText	50	Event identifier. Link to tbl_Events.
Updated_Date	dbText	50	Date of data verification, validation, or last change.
Contact_ID	dbText	50	Database user at data entry. Link to tlu_Contacts.
Data_Notes	dbText	255	Specific description of data history record (error-checking, data fields edited, etc).

TABLE NAME: **xref_Event_Contacts**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Cross-reference table between events and contacts.
FORMAT: Microsoft Access
NO. OF FIELDS: 3

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
Event_ID	dbText	50	Link to tbl_Events.
Contact_ID	dbText	50	Link to tlu_Contacts.
Contact_Role	dbText	50	The contact's role in the protocol.

TABLE NAME: **tbl_Transect_Locations**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Sampling unit locations.
FORMAT: Microsoft Access
NO. OF FIELDS: 17

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
Transect_ID	dbText	50	Transect location identifier.
Site_ID	dbText	50	Link to tbl_Sites.
GIS_Location_ID	dbText	50	Link to GIS feature, equivalent to NPS_Location_ID.
Meta_MID	dbText	50	Link to NR-GIS Metadata Database.
X_Coord	dbDouble	8	X coordinate.
Y_Coord	dbDouble	8	Y coordinate.
Coord_Units	dbText	50	Coordinate distance units.
Coord_System	dbText	50	Coordinate system.
UTM_Zone	dbText	50	UTM Zone.
Datum	dbText	50	Datum of mapping ellipsoid.
Est_H_Error	dbSingle	4	Estimated horizontal accuracy.
Accuracy_Notes	dbText	255	Positional accuracy notes.
Unit_Code	dbText	12	Park, Monument or Network code.
Loc_Name	dbText	100	Name of the location.
Loc_Type	dbText	25	Location type category.
Updated_Date	dbText	50	Date of entry or last change.
Loc_Notes	dbMemo	0	General notes on the location.

TABLE NAME: **tbl_Sites**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Location aggregations by stream.
FORMAT: Microsoft Access
NO. OF FIELDS: 6

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
Site_ID	dbText	50	Site identifier.
GIS_Location_ID	dbText	50	Link to GIS feature, equivalent to NPS_Location_ID.
Site_Name	dbText	100	Unique name or code for a site.
Site_Desc	dbText	255	Description for a site.
Unit_Code	dbText	12	Park, Monument or Network code.
Site_Notes	dbMemo	0	General notes on the site.

TABLE NAME: **tlu_Contacts**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Contact data for project-related personnel.
FORMAT: Microsoft Access
NO. OF FIELDS: 17

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
Contact_ID	dbText	50	Contact identifier.
Last_Name	dbText	50	Last name.
First_Name	dbText	50	First name.
Middle_Init	dbText	4	Middle initial.
Organization	dbText	50	Organization or employer.
Position_Title	dbText	50	Title or position description.
Address_Type	dbText	50	Address (mailing, physical, both) type.
Address	dbText	50	Street address.
Address2	dbText	50	Address line 2, suite, apartment number.
City	dbText	50	City or town.
State_Code	dbText	8	State or province.
Zip_Code	dbText	50	Zip code.
Country	dbText	50	Country.
Email_Address	dbText	50	E-mail address.
Work_Phone	dbText	50	Phone number.
Work_Extension	dbText	50	Phone extension.
Contact_Notes	dbMemo	0	Contact notes.

TABLE NAME: **tlu_Enumerations**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Enumerated lookup table.
FORMAT: Microsoft Access
NO. OF FIELDS: 4

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
Enum_Code	dbText	50	Code for lookup values.
Enum_Description	dbMemo	0	Lookup value description.
Enum_Group	dbText	50	Category for lookup value.
Sort_Order	dbInteger	2	Order in which to sort lookup values.

TABLE NAME: **tlu_Plant_List**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Look-up table on Pinnacles NM plant species.
FORMAT: Microsoft Access
NO. OF FIELDS: 22

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
TSN	dbLong	4	ITIS taxonomic serial number.
Sp_Code	dbText	255	Alpha-numeric plant species code.
Genus	dbText	255	Genus of species.
Species	dbText	255	Species.
Var_Ssp	dbText	255	Variety or subspecies.
Subspecies	dbText	255	Variety or subspecies name.
Full_Species_Name	dbText	250	Complete latin name.
Common_Name	dbText	250	Common name.
Family	dbText	250	Plant family.
Life Form	dbText	50	Life form, tree (T), shrub (S), or herb (H).
California	dbText	255	California wetland indicator.
National_Indicator	dbText	255	National wetland indicator.
Descriptive _Note	dbText	250	Descriptive note about plant or data record, if applicable.
Non_Native	dbBoolean	1	Nonnative species, yes or no.
State_Weed_Status	dbText	255	State weed status, if applicable.
Cal_IPC	dbText	255	California Invasive Plant Council weed status, if applicable.
Early_Detection	dbBoolean	1	Species targeted under SFAN Early Detection Protocol, yes or no.
Federal _Status	dbText	255	Federal listing status under the Endangered Species Act, if applicable.
State_Status	dbText	255	State listed status, if applicable.
CNPS_Status	dbText	255	Listing status by California Native Plant Society, if applicable.
RED_Code	dbText	255	CNPS code for Rarity, Endangerment, and Distribution, if applicable.
CNPS_Key	dbBoolean	1	Species is used in the California Native Plant Society Plant Community Key, yes or no.

TABLE NAME: **tlu_Wildlife_Species**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Look-up table of wildlife watch list species codes.
FORMAT: Microsoft Access
NO. OF FIELDS: 4

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
TSN	dbLong	4	ITIS taxonomic serial number.
Wildlife_Code	dbText	255	Wildlife watch-list species code.
Scientific name	dbText	255	Scientific name of species.
Common name	dbText	255	Common name of species.

TABLE NAME: **tbl_Db_Meta**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Database description and links to I&M metadata tools.
FORMAT: Microsoft Access
NO. OF FIELDS: 5

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
Db_Meta_ID	dbText	50	Local primary key.
Db_Desc	dbMemo	0	Description of the database purpose.
Meta_MID	dbText	255	Link to NPS Data Store.
DSC_GUID	dbText	50	Link to I&M Dataset Catalog desktop metadata tool.
Meta_File_Name	dbText	50	Name of the metadata file that describes this NRDT data file.

TABLE NAME: **tbl_Db_Revisions**
FILENAME: PINN_Wetlands_NRDT_v1_0.mdb
DESCRIPTION: Database revision history data.
FORMAT: Microsoft Access
NO. OF FIELDS: 6

FIELD NAME	FIELD TYPE	FIELD WIDTH	FIELD DESCRIPTION
Revision_ID	dbText	50	Database revision (version) number or code.
Revision_Contact_ID	dbText	50	Link to tlu_Contacts.
Db_Meta_ID	dbText	50	Link to tbl_DB_Meta.
Revision_Date	dbDate	8	Database revision date.
Revision_Reason	dbMemo	0	Reason for the database revision.
Revision_Desc	dbMemo	0	Revision description.

SOP 5. Detailed Field Methods

Revision History Log

Prev. Version #	Revision Date	Authors	Changes Made	Reason for Change	New Version #
-	September 2009	Denn, M., Ryan, A.B.	-	-	1.0

Figures

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Tables

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Introduction

Field observers will begin data collection either at a GPS point marking the point at which the stream channel crosses the park boundary as indicated by coordinates uploaded to the field GPS unit (see SOP 6), or at the lower end of a stream where it enters into another park stream (see Protocol Narrative Chapter 2). During the first year of data collection the observers will choose a random number between 1 and 3 for each stream to determine which reach the cross-channel transect will be placed in (*i.e.,* the first reach observed, the second reach, or the third reach). Every third transect thereafter in that stream will also have a cross-channel transect.

Observers will start at the lowest-elevation of each channel and walk upstream. At the beginning point of each stream observers will record the coordinates of the downstream point (the "reachpoint") with the GPS unit, and give a number to the reach at the reachpoint. The reach number will be the name of the stream, as found in Protocol Narrative Chapter 1, and a sequential number (*e.g.,* Chalone 1). The observers will also note the elevation of the reachpoint from the GPS unit, and measure the bankfull width of the channel at the reachpoint (to the nearest 0.1 m) - either with the 25-meter tape (for single channel streams less than 10 m wide) or with the rangefinder (for double channel streams, or streams more than 10 m wide). For streams with two bankfull channels, the observers will note the width of each channel and also the total width of the channel (including upland area in the center of the channel).

For the first reach in a stream the Hydrogeomorphology Technician (HT) will place a chain pin at the channel center at the reachpoint and reel out the 100-meter tape upstream, following the channel center. While reeling out the tape, the HT will count his/her paces to calibrate pacing for that stream type. The HT will also be noting characteristics about the channel. At the beginning of the field season the HT may need to walk the first few reaches of every stream several times to collect all necessary data; later in the season familiarity with the metrics will allow the HT to collect data through one or two observations of the reach. The HT will observe channel conditions adequately to rate the CRAM-derived metrics and indicate the presence of anthropogenic influences.

In subsequent non-transect reaches the HT may pace the 100-meter reach lengths, rather than measure them. The HT should pace in 25-meter segments, and at the end of each 25-m segment place a chain pin in the channel center as a marker for the Botany Technician. The chain pins will have numbered flags (labeled “1”, “2” and “3”) so that the Botany Technician will be sure to not miss a pin. Reaches with transects (every third reach) will need to be measured with the 100-m tape, and the HT will recalibrate his/her pacing against the tape in each of these reaches. The HT should maintain the ability to pace 100-meter reaches, with the number of paces not varying more that 5% per calibration.

The Botany Technician (BT) will follow the HT upstream, collecting the tape or chain pins, and collecting data regarding the dominant vegetation community type of the channel and floodplain (see SOP 7 for vegetation community classification), dominant plant species, and wetland presence.

Both the BT and HT will note any Weed Watch or Wildlife Watch species observed in the area (see SOP 8 for list) and note these on the Botany Datasheet at the end of the reach. If the reach cannot be observed due to hazardous conditions (*e.g.,* dense vegetation, poison oak, deep water), the field technicians will note that on the datasheet and not attempt to collect data for the reach.

Classification of Vegetation Communities and Characterization of Dominant Plant Species

Before Field Work Begins

Before field work begins the first step undertaken by the BT should be to become familiar with the plants species and communities that are likely to be encountered. Besides the park's general plant list and regional floras, there are several sources that are recommended for initial familiarization:

a. The list of vegetation communities (see SOP 8). This list tells you not only what plant species are found in the park, but what other species they are likely to occur with. This resource can help pinpoint the identity of an unknown common or dominant plant if other community dominants are known.

b. The list of riparian plant species that occur in Pinnacles NM. These are the species you are most likely to come across in your monitoring efforts

c. The pilot data or previous years' data of plants occurring in the watershed you are about to visit.

d. The photographic plants guide associated with this monitoring protocol (not yet completed, to be compiled as part of first full year of data collection)

Plant Species List and Codes

Any plant species which has not been encountered before will be recorded on the plant list carried by the BT. Six letter codes should be written on the plant list kept by the BT next to the full plant name. Six letter codes comprise the first three letters of the genus and species name of each plant. For example, *Juncus balticus* is written as JUNBAL. If two species have the same six letter code, an additional number may be added after the code. This will also be recorded on the plant species list. Any species which is unknown should be collected and/or photographed for later keying at the office. In the field, unknowns should be kept track of by designating them as "Unknown 1", "Unknown 2", *etc.,* or numbered by family or guild (*e.g.,* "Asteraceae1"). These can be written on the plant list with a short description until they are keyed, at which time they should be replaced with the correct species name and the datasheet updated.

Determining Reach Dominant Plants

Characterization of the dominant plant species should begin by estimating absolute percent cover for all plant species which occupy greater than 5 % of the reach between bankfull channels. Six letter codes may be used to record plant species.

Table SOP 5.1. Plant height classes.

Category Name	Plant Height
Very Tall	>3 m
Tall	1.5–3 m
Medium	0.75–1.5 m
Short	<0.75 m

The BT will write down each species within the appropriate layer (Table SOP 5.1). A single species will be recorded in each layer for which it occupies a significant portion of the reach (*e.g., Pinus sabiniana*, will be recorded twice if both seedlings and trees have significant cover).

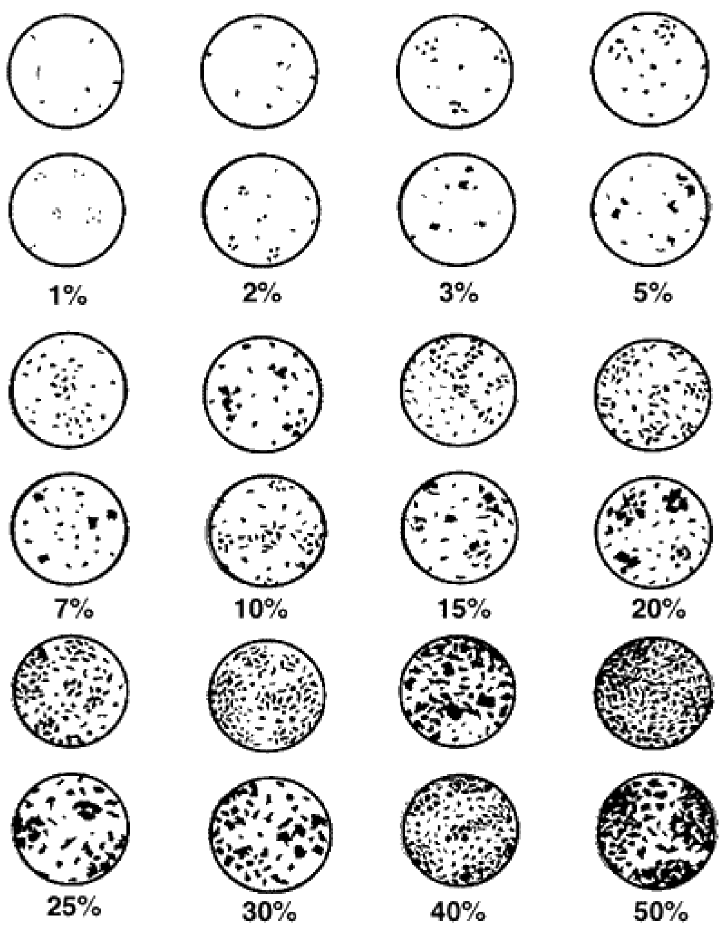

Figure SOP 5.1. Visualizing percent cover. (Source: http://ilmbwww.gov.bc.ca/risc/pubs/teecolo/fmdte/veg.htm.)

Since the BT will ideally only be traveling each transect once, it may be difficult to judge at times whether a plant occupies greater than 5% of the reach. The channel is assumed to be relatively uniform for the duration of the reach. Since the entire reach is not always visible at once, the BT should record any species that seems to occupy a significant portion of the reach. In most reaches one should be able to see far enough ahead to roughly evaluate the abundance of that plant species within the reach. The following techniques for cover estimate have been developed to minimize the error in cover estimates and variation between individuals:

a. Calibrate your eye to recognize percent cover using Figure SOP 5.1 depicting a birds-eye view of different percent cover as a reference.

b. List all plant species observed while walking up the channel. Note, with a tic mark on the list, which species would comprise 100% cover for 1 meter of distance along the channel length. The tick marks can be tallied at the reach end, each mark representing 1% cover for this species. In order for the BT to be able to estimate 1 meter distance along the channel, the BT should also be aware of their pace length, or may use the stadia rod to measure. Pace length may be calibrated with the HT at the first transect of the stream section and recalibrated within the 25-meter segments.

c. As an additional potentially-useful tool for observers: you may estimate cover for species that occupy a generally uniform-width area along one or both banks along the entire 100-meter reach, or for some large percentage along the 100-meter reach (*e.g.*, 6 meters in length within the 100-meter-long reach) by first estimating the species' percent cover *within* that occupied area, then using the stadia rod to estimate zone width (Figure SOP 5.2), and then combining these measures to estimate overall cover within the 100-meter reach. For example, a species with 33% cover in its occupied area, if the occupied area covers ½ the cross-section in width, will have 1 percent cover for every 6 m of occupied habitat along the channel length.

d. Use the 25-meter segments to guide estimates (see Dethier *et al.* 1993). While the entire reach is often not visible at once, 25-meter segments are generally visible. The BT will assume each segment represents ¼ of the reach and use this to conceptualize cover.

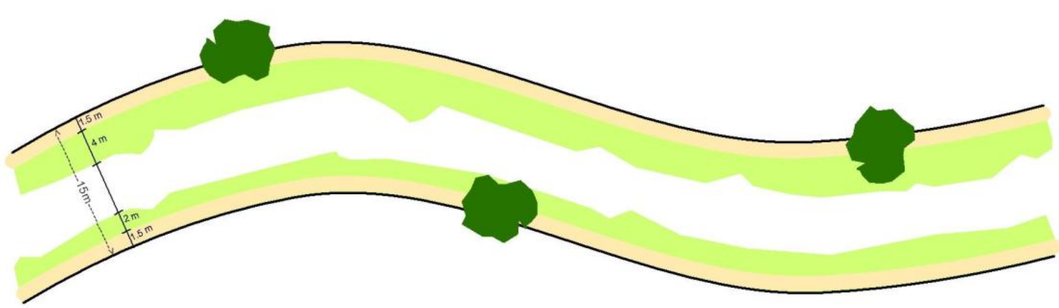

Figure SOP 5.2. Using zonation to estimate cover. The upper zone (tan) occupies a total of roughly 20% of the channel reach and the lower zone (green) occupies 40%.

Once the absolute cover of each species is estimated, tally the total percent cover for all plant species within each layer (short, medium, tall, and very tall). The dominant species for each layer can also be determined. These data will be used to key out the vegetation community.

Vegetation Communities

Vegetation communities are assigned using the Draft Key to the Plant Associations of Pinnacles National Monument (see SOP 7). Plant associations/communities are determined by a diagnostic layer. The diagnostic layer is the tallest layer that occupies more than 10% of the reach, including the channel and the floodprone area (see Figure SOP 5.3). Except for a couple communities that generally contain very sparse vegetation, layers are ignored if they do not cover at least 8% (tree layer) or 5% (shrub or herbaceous layers). Therefore, once you have tallied dominants, use the tallest dominants to guide you through the key. Try to find the best fit and do not worry if the community varies slightly. However, if it does not resemble any described community, key it to the physiognomic group and add "not yet described" (*e.g.*, Riparian/Mesic Draw Forest and Woodlands – not yet described).

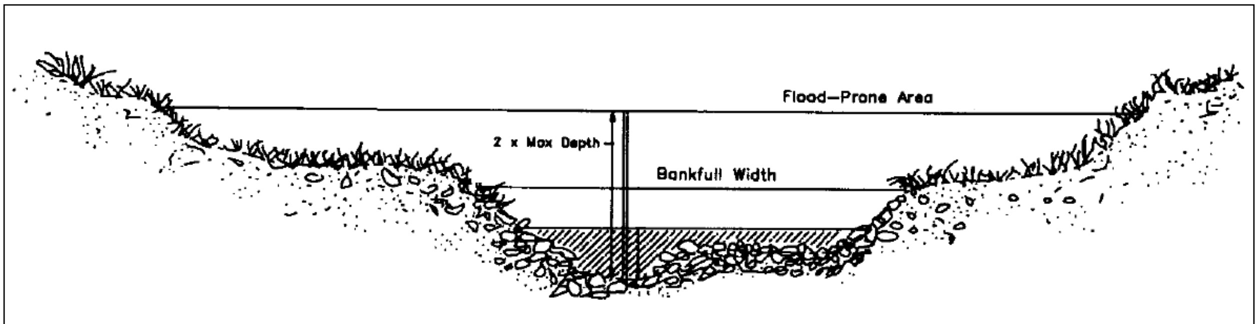

Figure SOP 5.3. Vegetation communities characterized for each reach, including the channel and the floodprone area (image adapted from Flosi *et al.* 1996).

Table SOP 5.2. Plant associations of Pinnacles National Monument

Community Type		Code
Woodlands and Forests		
Riparian/Mesic Draw Forest and Woodlands		
	Quercus agrifolia / Toxicodendron diversilobum Intermittently Flooded Woodland	F1
	Platanus racemosa - *Quercus agrifolia var. agrifolia* Woodland	F2
	Platanus racemosa – Salix laevigata / Rubus ursinus Woodland	F3
	Platanus racemosa Temporarily Flooded Woodland	F4
	Salix laevigata / Artemisia douglasiana - Rubus ursinus Woodland	F5
	Populus fremontii –Salix laevigata Woodland	F6
	Populus fremontii / Baccharis salicifolia Woodland	F7

Table SOP 5.2. Plant associations of Pinnacles National Monument (continued).

Community Type		**Code**
Upland/Dry Forests and Woodlands		
	Aesculus californica / Toxicodendron diversilobum / Moss Woodland	F8
	Quercus agrifolia - Aesculus californica Woodland	F9
	Juniperus californica / Prunus ilicifolia / Moss Woodland	F10
Coniferous Forest and Woodlands		
	Pinus sabiniana / Eriogonum fasciculatum Alluvial Woodland	F11
	Pinus sabiniana / Ceanothus cuneatus - Rhamnus ilicifolia Woodland	F12
	Quercus douglasii - Pinus sabiniana / *Cercocarpus montanus var. glaber* Woodland	F13
Oak and Mixed Oak-Conifer Forests and Woodlands		
	Quercus douglasii - Pinus sabiniana / Grass Woodland	F14
	Quercus douglasii - Juniperus californina Woodland *Quercus douglasii* / Mixed Herbaceous Woodland	F15
	Quercus agrifolia / Annual Grass-Forb Woodland	F15
	Quercus lobata - Quercus agrifolia / Annual Grass - Herb Woodland	F17
	Quercus wislizeni - Pinus Sabiniana / Mixed Herbaceous Woodland	F18
	Woodland type not yet described for Pinnacles National Monument.	F19
	Wetland, Riparian, and Wash Shrublands	F20
	Baccharis salicifolia Riparian Shrubland	F21
	Salix exigua Temporarily Flooded Shrubland	F22
	Salix lasiolepis / Baccharis salicifolia Shrubland	F23
	Salix lasiolepis / Rosa californica Shrubland	F24
Shrublands		
Upland/Dry to Mesic Shrublands		
	Baccharis pilularis / Annual Grass - Herb Shrubland	S1
Weedy, Disturbance-driven Shrublands		
	Lotus scoparius Shrubland Association	S2
	Lupinus albifrons - Senecio flaccidus var. douglasii Shrubland	S3
	Upland Chaparral Shrublands (may be recovering from natural disturbance)	S4
A. fasciculatum Shrublands		
	Adenostoma fasciculatum - Salvia mellifera Shrubland	S5
	Adenostoma fasciculatum - Ceanothus cuneatus var. cuneatus Shrubland	S6
	Adenostoma fasciculatum - Arctostaphylos glauca Shrubland	S7
	Adenostoma fasciculatum - Arctostaphylos pungens Shrubland	S8
	Adenostoma fasciculatum / Selaginella bigelovii Shrubland	S9
	Adenostoma fasciculatum / Selaginella bigelovii Shrubland	S10
	Adenostoma fasciculatum Shrubland	S11
Prunus ilicifolia Shrublands		
	Prunus ilicifolia - Fraxinus dipetala Shrubland	S12
	Prunus ilicifolia - Ceanothus cuneatus Shrubland	S13
	Prunus ilicifolia - Heteromeles arbutifolia Shrubland	S14

Table SOP 5.2. Plant associations of Pinnacles National Monument (continued).

Community Type		**Code**
	Prunus ilicifolia Shrubland	S15
Salvia mellifera Shrublands		
	Salvia mellifera - Eriogonum fasciculatum / Bromus madritensis Shrubland	S15
	Salvia mellifera Shrubland	S17
Other Shrubland Types		
	Arctostaphylos glauca Shrubland	S18
	Artemisia californica Shrubland	S19
	Artemisia californica – Eriogonum fasciculatum Shrubland	S20
	Eriogonum fasciculatum Shrubland	S21
	Eriogonum fasciculatum / Selaginella bigelovii Herbaceous Vegetation	S22
	Diplacus aurantiacus Shrubland	S23
	Ceanothus cuneatus Shrubland	S24
	Cercocarpus montanus var. glaber Shrubland	S25
	Quercus berberidifolia - Cercocarpus montanus var. glaber Shrubland	S26
	Quercus berberidifolia Shrubland	S27
	Unclassified: Rhamnus ilicifolia - Clematis lasiantha Shrubland	S28
	Shrubland community not yet described from Pinnacles NM	S29
Herbaceaous Communities		
Wetland and Mesic Herbaceous Communities		
	Mimulus guttatus – (Mimulus spp.) Herbaceous Vegetation	H1
	Eleocharis macrostachya Herbaceous Vegetation	H2
	Leymus triticoides Herbaceous Vegetation	H3
	Juncus balticus Herbaceous Vegetation	H4
	Hordeum brachyantherum Herbaceous Vegetation	H5
Upland/Dry Herbaceous Communities		
	Sedum spathulifolium - Moss - Bedrock Vegetation	H6
	Eriogonum fasciculatum / Selaginella bigelovii Herbaceous Vegetation	H7
	Lichen Gravel - Bedrock Nonvascular Sparse Vegetation	H8
	Collinsia heterophylla - Lichen Sparse Vegetation	H9
	Eriogonum wrightii - Lichen Sparse Vegetation	H10
	(*Artemisia dracunculus*) - *Gnaphalium canescens* Herbaceous Vegetation	H11
	Artemisia dracunculus Alluvial Fan Herbaceous Vegetation	H12
	Eriogonum elongatum Herbaceous Vegetation	H13
	Avena fatua - (Nassella pulchra - Plantago erecta) Herbaceous Vegetation	H14
	Erodium brachycarpum - Bromus hordeaceus - Bromus madritensis Herbaceous Vegetation	H15
	Hordeum brachyantherum Herbaceous Vegetation	H15
	Muhlenbergia rigens Herbaceous Vegetation	H17
	Eschscholzia californica Herbaceous Vegetation	H18
	Heterotheca sessiliflora ssp. echioides Herbaceous Vegetation	H19

Table SOP 5.2. Plant associations of Pinnacles National Monument (continued).

Community Type		Code
	Unclassified Herbaceous: *Eriogonum nudum*	H20
	Unclassified Herbaceous: *Epilobium canum*	H21
	Unclassified: *Vulpia bromoides - Deiandra lobbii*	H22
	Unclassified: *Vulpia bromoides - Plagiobothrys canescens - Amsinckia menziesii*	H23
	Unclassified: *Avena barbata - Melica imperfecta*	H24
	Herbaceous Community not yet described from Pinnacles National Monument.	H25

Identification and Classification of In-Channel Wetlands

In each 25-meter segment the BT will record the type, hydrologic and vegetation indicators and size class of wetlands.

"Wetlands" for the purpose of this protocol are: areas of any size within the stream channel that exhibit a preponderance of wetland plants, based on the Army Corps of Engineers wetlands delineation methodology (Environmental Laboratories 1987), and exhibits indicators of wetland hydrology, also based on the Army Corp of Engineers methodology. Any wetlands identified in this protocol must fall into one of the Cowardin classification systems (Cowardin *et al.* 1979) and classes. This protocol will not require identification of hydric soils in areas deemed "wetlands" as most of the wetlands within the channels at Pinnacles NM exhibit no or only poorly developed soils due to frequent channel bed mobilization.

"Type" refers to the Cowardin classification of the wetland. The Cowardin classification system was developed by the USFWS National Wetland Inventory for the mapping and classification of wetlands. This system is fully described in the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin *et al.* 1979). This classification method categorizes wetlands into several categories: System, Subsystem, Class, and Water Regime modifiers. Each category has several possible descriptors to choose from, and each descriptor has been assigned a code of one-two letters and numbers. Table SOP 5.3 describes the classes and water regime modifiers applicable at Pinnacles NM and provides their code.

The BT will write the codes in the data sheet following the order of System, Subsystem, Class, and Water Regime. At Pinnacles, all in-channel wetlands are considered to be of the System "Palustrine" for which there are no subsystems. So, for example, a wetland dominated by emergent rushes and that appeared to be seasonally saturated would be recorded at PEMB.

Table SOP 5.3. Applicable Cowardin classes.

Code	Class
AB	Aquatic Bed – The Class Aquatic Bed includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years.
EM	Emergent Wetland – The Emergent Wetland Class is characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.
FO	Forested Wetland – The Class Forested Wetland is characterized by woody vegetation that is 6 m tall or taller.
ML	Moss-lichen Wetland – The Moss-Lichen Wetland Class includes areas where mosses or lichens cover substrates other than rock and where emergents, shrubs, or trees make up less than 30% of the aerial cover.
RB	Rock Bottom - The Class Rock Bottom includes all wetlands and deepwater habitats with substrates having an aerial cover of stones, boulders, or bedrock 75% or greater and vegetative cover of less than 30%.
SS	Scrub-shrub Wetland - The Class Scrub-Shrub Wetland includes areas dominated by woody vegetation less than 6 m (20 ft) tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions.
UB	Unconsolidated Bottom - The Class Unconsolidated Bottom includes all wetland and deepwater habitats with at least 25% cover of particles smaller than stones, and a vegetative cover less than 30%.

Table SOP 5.4. Applicable Cowardin water regime modifiers.

Code	Water Regime Modifier
A	Temporarily Flooded - Surface water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season. Plants that grow both in uplands and wetlands are characteristic of the temporarily flooded regime.
B1	Seasonally Saturated/Well Drained - Surface water is seldom present, but substrate is saturated to the surface and drains relatively rapidly after seasonal rainfall and/or run-off ceases.
B2	Seasonally Saturated Surface water is seldom present, but substrate is saturated to the surface for extended periods following seasonal rainfall and/or runoff.
B3	Permanently Saturated Surface water is seldom present, but substrate is saturated to the surface throughout the year.
C1	Seasonally Flooded/Well Drained - Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the land surface. It is also well drained.
C2	Seasonally Flooded/Seas. Saturated - Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. Surface water can also persist at times during the year.
C3	Seasonally Flooded/Perm. Saturated - Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the land surface.
F	Semi-permanently Flooded - Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.
G	Intermittently Exposed Surface water is present throughout the year except in years of extreme drought.
H	Permanently Flooded - Water covers the land surface throughout the year in all years. Vegetation is composed of obligate hydrophytes.
J	Intermittently Flooded - The substrate is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity. Weeks, months, or even years may intervene between periods of inundation. The dominant plant communities under this regime may change as soil moisture conditions change. Some areas exhibiting this regime do not fall within our definition of wetland because they do not have hydric soils or support hydrophytes.
K	Artificially Flooded Duration of flooding is controlled by artificial means (*i.e.,* pumps, siphons, dikes, dams, *etc.*)
X	Phreatophytic Surface water may be present episodically after major storm events, but plants reliant on water tables below the soil surface (>1.5 ft).
Y	Saturated/Semi-permanent/Seasonal
Z	Intermittently Exposed/Permanent

The BT will also record a “hydrology indicator” from the list below (Table SOP 5.5), adapted from the Army Corps of Engineer's Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region (USACOE 2008). Hydrology indicators are indicators that water has been on site for a significant portion of the growing season. The most obvious indicators of hydrology are surface water or saturation. Other common indicators include a biotic crust such as dried algae and aquatic invertebrates, and water-stained leaves.

Table SOP 5.6. Wetland hydrology indicators and codes.

Codes	Hydrology Indicator
A1	Surface Water
A2	High Water Table
A3	Saturation
B6	Surface Soil Cracks
B7	Inundation Visible on Aerial Imagery
B9	Water-Stained Leaves
B11	Salt Crust
B12	Biotic Crust
B13	Aquatic Invertebrates
C1	Hydrogen Sulfide Odor
C3	Oxidized Rhizospheres along Living Roots
C4	Presence of Reduced Iron
C6	Recent Iron Reduction in Tilled Soils
Explain in remarks	Other

In the "vegetation indicator" space the BT will record the plant species which dominates the wet area and the wetland indicator status of that plant. If there is more than one dominant, record the plant species that has the indicator status with the highest frequency of occurrence in wetlands. The indicator status is used to determine the probability that a plant occurs in a wetland habitat (Table SOP 5.6). For the purposes of this monitoring protocol the indicator status will be those listed in the *National List of Plant Species That Occur in Wetlands* (Reed 1996). For a wetland dominated by *Mimulus guttatus* "vegetation indicator" would be recorded as MIMGUT OBL.

Table SOP 5.7. Definition of wetland indicator categories (Environmental Laboratories 1987).

Indicator Categories	Definition	Frequency of Occurrence in Wetlands
OBL	Obligate, always found in wetlands	>99 percent
FACW	Facultative wetland, usually found in wetlands	67–99 percent
FAC	Facultative, equal in wetlands or non-wetlands	34–66 percent
FACU	Facultative upland, usually found in non-wetlands	1–33 percent
UPL/NI	Upland/No Indicator, not found in local wetlands	<1 percent

California Rapid Assessment Method Derived Metrics

While walking up each 100-meter reach, the Hydrogeomorphology Technician will evaluate the following CRAM-derived metrics for the reach. All CRAM-derived metric descriptions and graphics adapted from Collins *et al.* 2008.

Buffer Condition

The buffer is the area adjoining the reach: within 500 m upstream, downstream, and on either side of the channel, that is in a natural or semi-natural state and currently not dedicated to anthropogenic uses that would severely detract from its ability to entrap contaminants, discourage forays into the reach by people and non-native animals, or otherwise protect the reach from stress and disturbance.

A. Buffer of reach is dominated by native vegetation, has undisturbed soils (*i.e.,* direct anthropogenic disturbance), and is apparently subject to little or no human visitation.

B. Buffer of reach is characterized by an indeterminate mix of native and non-native vegetation, but with mostly undisturbed soils, and is apparently subject to little or no human visitation.

C. Buffer of reach is characterized by substantial amounts of non-native vegetation, AND there is at least a moderate degree of soil disturbance or compaction, and/or there is evidence of at least moderate intensity of human visitation.

D. Buffer of reach is characterized by barren ground due to human influence and/or highly compacted and/or otherwise disturbed soils, and/or there is evidence of very intense human visitation.

Channel Stability

Field observers should first note indicators of Channel Equilibrium, Active Degradation, and Active Aggradation; then circle the predominant trend (equilibrium, degradation, or aggradation); then use the letter scoring to indicate the apparent severity of the trend.

Indicators of Channel Equilibrium:

1. Perennial riparian vegetation is abundant and well-established along the bankfull contour, but not below it.
2. There is leaf litter, thatch, or wrack (not this year's growth) in most pools.
3. The channel contains embedded woody debris of the size and amount consistent with what is naturally available in riparian areas.
4. There is little or no active undercutting or burial of riparian vegetation.
5. There are no mid-channel bars and/or point bars densely vegetated with perennial vegetation.
6. Channel bars consist of well-sorted bed material.
7. There are channel pools, the bed is not planar, and the spacing between pools tends to be regular.
8. The larger bed material supports abundant mosses or periphyton.

<u>Indicators of Active Degradation:</u>

1. The channel is characterized by deeply undercut banks with exposed living roots or shrubs.
2. There are abundant bank slides or slumps, or the lower banks are scoured and not vegetated.
3. Riparian vegetation is declining in stature or vigor, or many riparian trees and shrubs along the banks are leaning or falling in the channel.

4. An obvious historic floodplain has recently (< past 50 years) been abandoned, as indicated by the age structure of riparian vegetation.
5. The channel bed appears scoured to bedrock or dense clay.
6. Recently active flow pathways appear to have coalesced into one channel (*i.e.*, a previously braided system is no longer braided).
7. The channel has one or more nick points indicating headward erosion of the bed.

<u>Indicators of Active Aggradation:</u>

1. There is an active floodplain with fresh splays of coarse sediment.
2. There are partially buried living tree trunks or shrubs along the banks.
3. The bed is planar overall; it lacks well-defined channel pools, or they are uncommon and irregularly spaced.
4. Perennial terrestrial or riparian vegetation is encroaching in to the channel or onto channel bars below the bankfull contour.
5. There are secondary channels on the floodplain or adjacent valley floor.

<u>Channel Stability:</u>

A. Most of the channel through the reach is characterized by equilibrium conditions; with little evidence of aggradation or degradation.

B. Most of the channel through the reach is characterized by some aggradation or degradation, non of which is severe, and the channel seems to be approaching an equilibrium form.

C. There is abundant evidence of severe aggradation or degradation of most of the channel through the reach.

D. The channel is artificially hardened through most of the reach.

<u>Structural Patch Richness (Habitat Components):</u>

The structural Patch Richness elements (Figure SOP 5.4) refer to potential habitat for plant and animal species, not complexity of structures and processes for the purpose of evaluating creek geomorphological trajectory.

1. Pools or depressions in bankfull channel(s):
   Pools are areas along tidal and fluvial channels that are deeper than the average depths of their channels and that tend to retain water longer than other areas of the channel during periods of low or no surface flow.
2. Riffles or rapids (wet channel):
   Riffles and rapids are areas of relatively rapid flow and standing waves in tidal or fluvial channels. Riffles and rapids add oxygen to flowing water and provide habitat for many fish and aquatic invertebrates.
3. Point bars and in-channel bars:
   Bars are sedimentary features within intertidal and fluvial channels.
   They are patches of transient bedload sediment that form along the inside of meander

bends or in the middle of straight channel reaches. They sometimes support vegetation. They are convex in profile and their surface material varies in size from small on top to larger along their lower margins. They can consist of any mixture of silt, sand, gravel, cobble, and boulders.

4. Debris jams in bankfull channel(s):
   A debris jam is an accumulation of drift wood and other flotage across a channel that partially or completely obstructs surface water flow.

5. Abundant wrackline or organic debris in channel or within floodprone area:
   Wrack is an accumulation of natural or unnatural floating debris along the high water line of a wetland.

6. Plant hummocks and/or sediment mounds in bankfull channel(s):
   Hummocks are mounds created by plants in slope wetlands, depressions, and along the banks and floodplains of fluvial and tidal systems. Hummocks are typically less than 1m high. Sediment mounds are similar to hummocks but lack plant cover.

7. Bank slumps or undercut banks in channels or along shoreline:
   A bank slump is a portion of a depressional, estuarine, or lacustrine bank that has broken free from the rest of the bank but has not eroded away. Undercuts are areas along the bank or shoreline of a wetland that have been excavated by waves or flowing water.

8. Standing snags (at least 3m tall) within floodprone area:
   Tall, woody vegetation, such as trees and tall shrubs, can take many years to fall to the ground after dying. These standing “snags” provide habitat for many species of birds and small mammals. Any standing, dead woody vegetation that is at least 3 m tall is considered a snag.

9. Filamentous microalgae or algal mats in bankfull channel(s):
   Macroalgae occurs on benthic sediments and on the water surface of all types of wetlands. Macroalgae are important primary producers, representing the base of the food web in some wetlands. Algal mats can provide abundant habitat for macro-invertebrates, amphibians, and small fishes.

10. Cobble and/or boulders:
    Cobble and boulders are rocks of different size categories. The long axis of cobble ranges from about 6 cm to about 25 cm. A boulder is any rock having a long axis greater than 25 cm. Submerged cobbles and boulders provide abundant habitat for aquatic macroinvertebrates and small fish. Exposed cobbles and boulders provide roosting habitat for birds and shelter for amphibians. They contribute to patterns of shade and light and air movement near the ground surface that affect local soil moisture gradients, deposition of seeds and debris, and overall substrate complexity.

11. Secondary channels in floodprone area:
    Channels confine riverine flow. A channel consists of a bed and its opposing banks, plus its floodplain. Riverine wetlands can have a primary channel that conveys most flow, and one or more secondary channels of varying sizes that convey flood flows. The systems of diverging and converging channels that characterize braided and anastomosing fluvial systems usually consist of one or more main channels plus secondary channels. Tributary channels that originate in the wetland and that only convey flow between the wetland and

the primary channel are also regarded as secondary channels. For example, short tributaries that are entirely contained within the reach are regarded as secondary channels.

12. Swales in floodprone area:
    Swales are broad, elongated, vegetated, shallow depressions that can sometimes help to convey flood flows to and from vegetated marsh plains or floodplains. But, they lack obvious banks, regularly spaced deeps and shallows, or other characteristics of channels. Swales can entrap water after flood flows recede. They can act as localized recharge zones and they can sometimes receive emergent groundwater.

13. Pannes or pools in floodprone area:
    A panne is a shallow topographic basin lacking vegetation but existing on a well-vegetated wetland plain. Pannes fill with water at least seasonally due to overland flow. They commonly serve as foraging sites for waterbirds and as breeding sites for amphibians.

14. Vegetated islands (mostly above high-water) between bankfull channels:
    An island is an area of land above the usual high water level and, at least at times, surrounded by water in a riverine, lacustrine, estuarine, or playa system. Islands differ from hummocks and other mounds by being large enough to support trees or large shrubs.

15. Submerged vegetation:
    Submerged vegetation consists of aquatic macrophytes such as *Elodea canadensis* (common elodea) that are rooted in the sub-aqueous substrate but do not usually grow high enough in the overlying water column to intercept the water surface. Submerged vegetation can strongly influence nutrient cycling while providing food and shelter for fish and other organisms.

<u>Topographic Complexity:</u>

A. Reach as viewed along a typical cross-section has at least two benches or breaks in slope, including the riparian area of the reach above the channel bottom, not including the thalweg. Each of these benches, plus the slopes between the benches, as well as the channel bottom area contain physical patch types or features such as boulders or cobbles, animal burrows, partially buried debris, slump blocks, furrows or runnels that contribute to abundant micro-topographic relief as illustrated in profile A Figure SOP 5.4.

B. Reach has at least two benches or breaks in slope above the channel bottom area of the reach but these benches and slopes mostly lack abundant micro-topographic complexity. The reach resembles profile B of Figure SOP 5.4.

C. Reach has a single bench or obvious break in slope that may or may not have abundant micro-topographic complexity, as illustrated in profile C of Figure SOP 5.4.

D. Reach as viewed along a typical cross-section lacks any obvious break in slope or bench. The cross-section is best characterized as a single, uniform slope with or without micro-topographic complexity, as illustrated in profile D of Figure SOP 5.4.

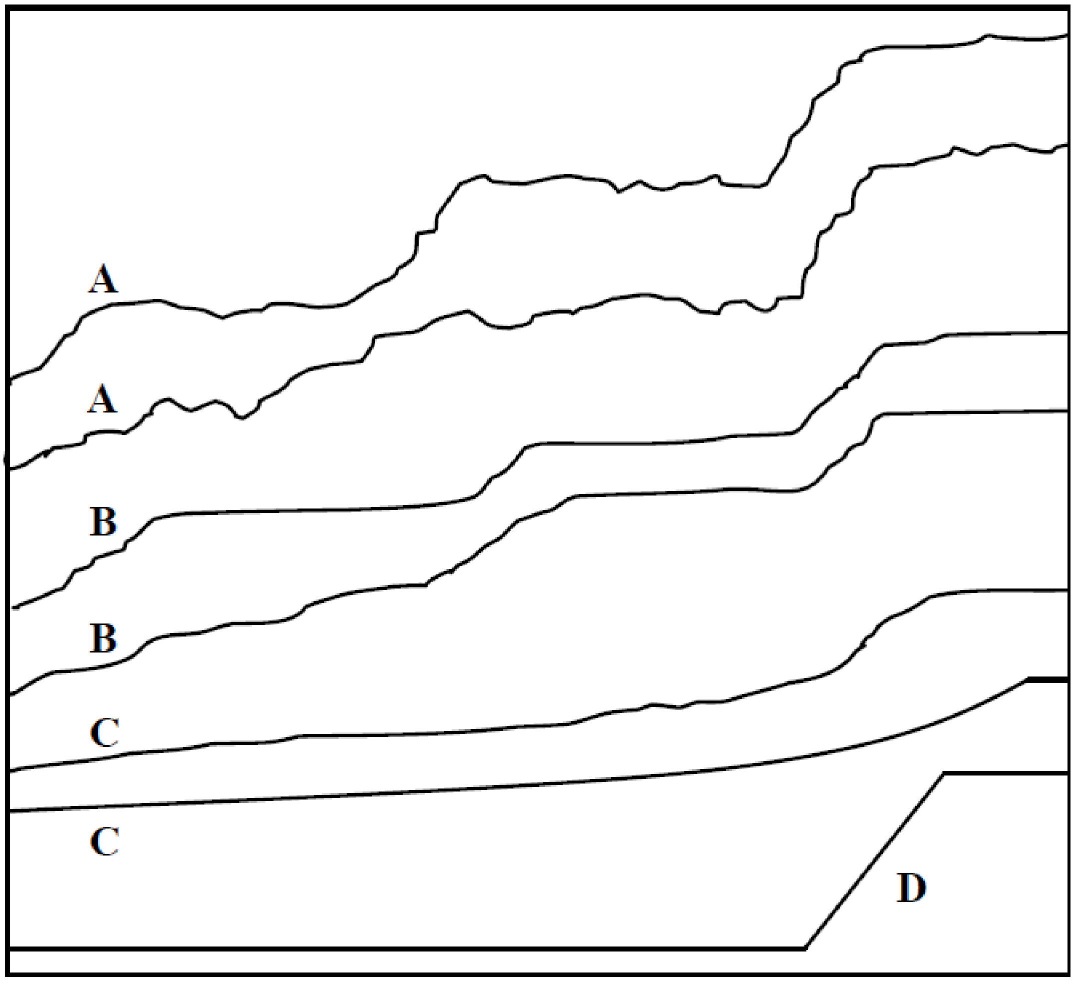

Figure SOP 5.4. Topographic complexity of channel cross-section.

Horizontal Interspersion and Zonation
Horizontal biotic structure refers to the variety and interspersion of plant “zones.” Plant ones are plant monocultures or obvious multi-species association that are arrayed along gradients of elevation, moisture, or other environmental factors that seem to affect the plant community organization in plan view. Interspersion is essentially a measure of the number of distinct plant zones and the amount of edge between them. See Figure SOP 5.5.

A. Reach has a high degree of plan-view interspersion.

B. Reach has a moderate degree of plan-view interspersion.

C. Reach has a low degree of plan-view interspersion.

D. Reach has essentially no plan-view interspersion.

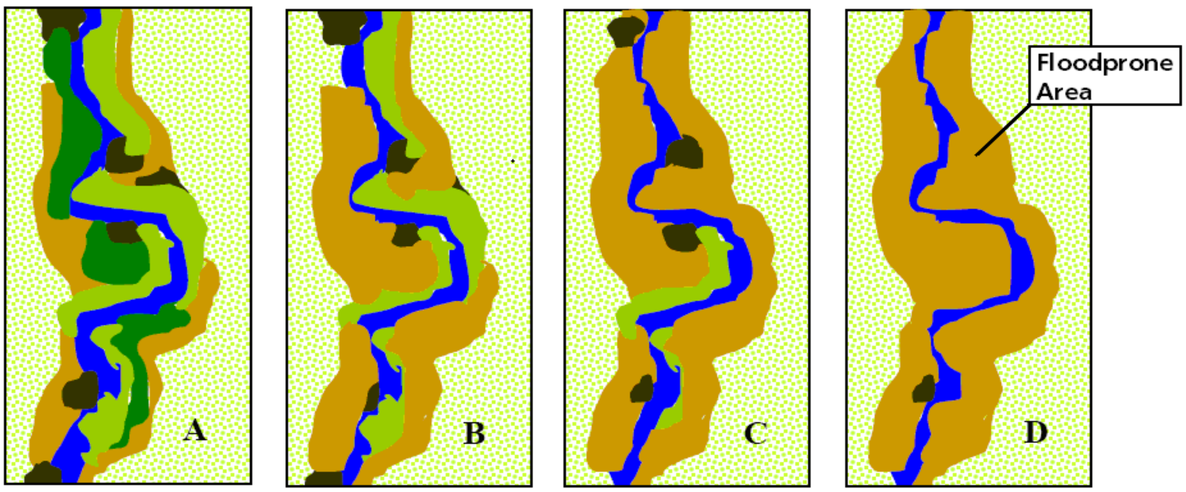

Figure SOP 5.5. Horizontal interspersion and zonation.

Vertical Biotic Structure

The vertical component of biotic structure consists of the interspersion and complexity of plant layers. The same plant layer categories used to characterize dominant vegetation species composition are used to assess Vertical Biotic Structure, however for this metric include all plants in the floodprone area. To be counted a layer must cover at least 5% of the portion of the floodprone area that is suitable for the layer. See Figure SOP 5.6.

A. More than 50% of the vegetated area of the reach supports abundant overlap of plant layers

B. More than 50% of the reach supports at least moderate overlap of plant layers.

C. 25–50% of the vegetated reach supports at least moderate overlap of plant layers, or three plant layers are well represented in the reach but there is little to no overlap.

D. Less than 25% of the vegetated reach supports moderate overlap of plant layers, or two layers are well represented with little overlap, or reach is sparsely vegetated overall.

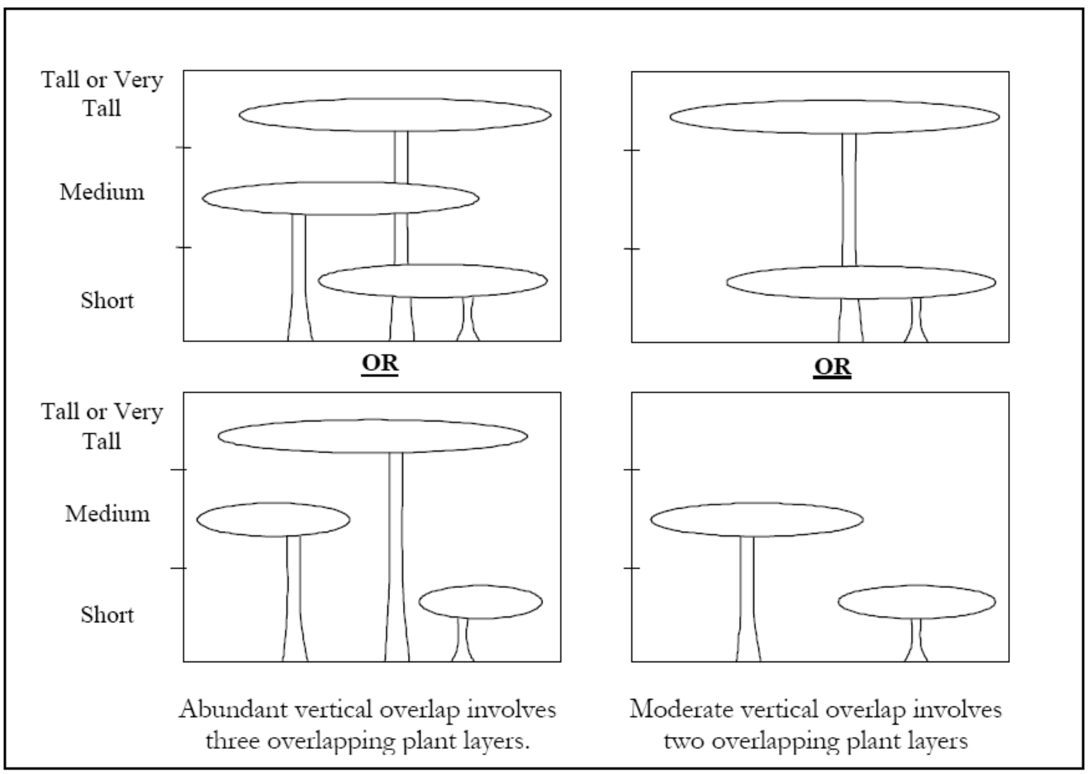

Figure SOP 5.6. Vertical biotic structure.

Anthropogenic Influences Observed in the Reach

While walking up each 100-meter reach the Hydrogeomorphology Technician will note if any of the anthropogenic influences listed in the final table in this section are present in the reach (table adapted from Collins *et al.* 2008).

Rosgen Stream Classification

While walking up each 100-meter reach, the Hydrogeomorphology Technician will observe the geomorphic characteristics of the channel, and assign the channel to one of the stream types in the Rosgen channel classification scheme.

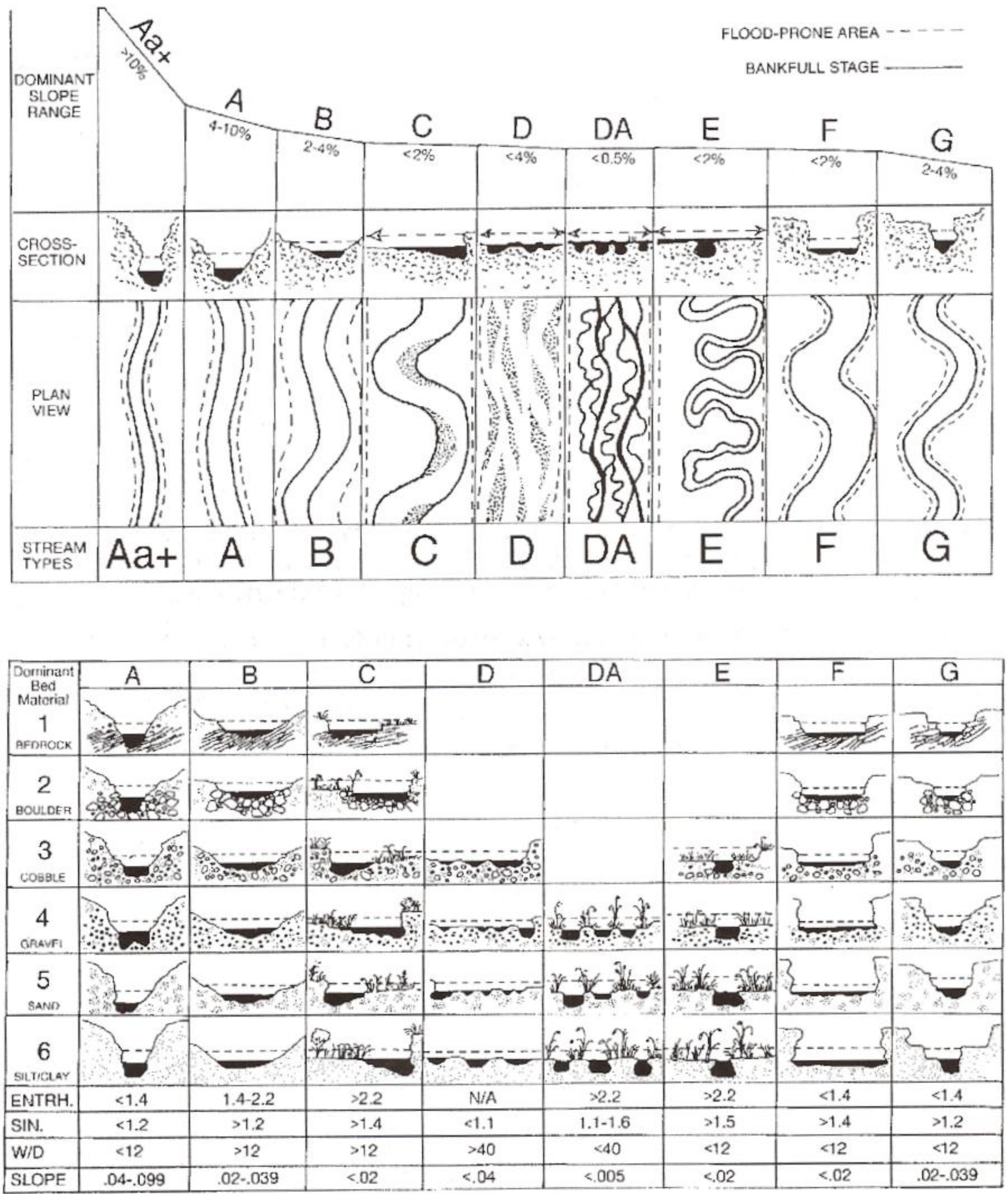

Figure SOP 5.7. Rosgen Stream Classification System. (image from Bunte and Abt 2001, as adapted from Rosgen 1996)

Transect data collection

Transect Establishment

During the first year of data collection field observers will set the transect locations. For each stream, starting at the most downstream reach within the stream network included in this study, observers will generate a random number (using either a calculator or random number table) between 1 and 3, which will indicate whether the 1st, 2nd, or 3rd reach (out of every three reaches) will include a transect. When observers reach the first transect reach, while traveling upstream, they will reel out the 100-meter tape from the "reachpoint" (at the "0" end of the tape) along the center of the channel. The observers will generate a random number between 0 and 99 to indicate the position along the tape where the transect will be located. For subsequent reaches in the channel the transect will fall in every third reach; the position of the transect in the reach will fall in a new random location within the reach (*i.e.,* observers will generate a new random number between 0 and 99 for each reach that includes a transect). When observers begin data collection on a new stream they will generate a new random number between 1 and 3 to determine which reaches in that stream will include transects.

When observers have located the position of the transect in the reach (between meters 0 and 99 on the 100-meter tape), one observer will stand in the middle of the channel and look directly upstream along the main direction of water flow at floodstage, and sight this bearing with the compass. The observer will then orient the transect between bankfull banks at a 90° angle to this compass bearing (*i.e.,* the transect will be perpendicular to the channel). The observers will place one chain pin at each end of the transect and reel the 25-meter tape between the bankfull banks. In the event that there are two bankfull banks at the transect location, the observers will repeat this transect orientation procedure for the second bankfull bank.

Observers will record the position of the center of the channel with the GPS unit. If there are two bankfull channels, observers will record the centers of both channels. These geographic coordinates will be used in subsequent years for observers to navigate back to the transect location, so observers will collect the most accurate location data possible.

In subsequent years observers will re-locate transect locations based on GPS data and photodocumentation. Observers will orient the transect perpendicular across the channel based on current observations regarding channel orientation, not using previous-years' compass bearings. Observers also will estimate transect length (between bankfull channels) for the current year, and not mimic transect lengths from previous years, in order to accommodate channel evolution over time.

Data Collection

Observers will record the distance between the bankfull channel banks, either with the 25-meter tape or the rangefinder, to 0.1 meter. For transects with two bankfull channels observers will record the bankfull channel width for each channel and the total width between outside bankfull banks (see graphic in section 2.2.2.3 of the protocol narrative).

Field technicians will take photos as necessary to document conditions at each transect for the purpose of relocating the transect in future years. Photos will be shot at a height of 1 meter off the channel bottom, looking upstream directly along the middle of the channel, at the middle of the transect. Observers will place the 1-meter stadia in the photo 10 m upstream from the transect, for scale, and note the photo number (from the camera) on the datasheet. Later in the office as a part of data entry, observers will rename photos with the transect number. Observers will use a digital camera of 8 megapixel sensor size or greater, a focal length of 50 millimeters, and optimize the camera for aperture priority (minimum aperture size, *i.e.*, a large aperture number). After the first year of data collection observers will carry print-outs of previous years' transect photos to assist with re-finding transect locations and recapturing the same scene.

Once the 25-meter tape has been reeled between bankfull banks the observers can collect transect data: one technician will record data on the Reach Condition Datasheet, while the other technician will use the point sampling tool and densitometer (see SOP 3) to sample vegetation and substrate across the channel. The transect observer will record "hits" at 20 to 30 points across the channel depending on bankfull width:

Table SOP 5.8. Distance between sample points based on bankfull width.

Channel Width at Bankfull	Distance Between Points on Transect Tape
0.5–1.0 m	0.05 m
1.1–1.5 m	0.075 m
1.6–3.0 m	0.1 m
3.1–4.5 m	0.15 m
4.5–6.0 m	0.2 m
6.1–7.5 m	0.25 m
7.6–9.0 m	0.3 m

The observer will begin at the "0" end of the tape by placing the stadia rod of the point sampling tool at the first chain pin at the beginning of the tape, with the pointing device of the point sampling tool oriented on the upstream side of the transect. The observer will level the point sampling tool with the two bubbles on the device, and slowly lower the point through the vegetation. The observer will note any tree/shrub species "hit" by the point, and indicate the species name to the recorder. The observer will also note if the pointing tool encounters a forb, grass, sedge, rush, litter (dead vegetation matter not the current year's growth), algal mat, surface water, and/or rocky substrate. The recorder will note a "hit" for any of these encounters, but not record species names.

For rocky substrate encountered, the observer will use the gravelometer (see SOP 3) to place the sand/pebble/rock/cobble/bedrock into a size category. The observer will pick up the substrate at the sample point, and note the smallest aperture in the gravelometer that the rock will fit through, which corresponds to size class system in Table SOP 5.9 (Bunte and Abt 2001).

Table SOP 5.9. Rock size classes.

Rock Size Class	Small-axis diameter (in millimeters)
r1	2
r2	4.9
r3	6.9
r4	9.7
r5	13
r6	19
r7	27
r8	39
r9	55
r10	77
r11	109
r12	154
r13	218
r14	309
bedrock	>309

When using the point intercept device, observers should be careful to lower the point down in a straight line without wavering; be cognizant that the "point" should be considered dimensionless, so only entities encountering the very point of the sharp tip of the tool should be counted as "hits"; and not drop the point roughly into the channel bed as this will move aside small surface particles and tend to bias the observations toward larger particles.

After recording encounters with the point sampling tool, observers will use the densitometer to include overhead foliar cover. Observers will leave the point sampling tool in place, and rest the densitometer on the upper aluminum tube of the tool, so that the densitometer is pointing upward directly above the point of the point sampling tool. The observer will place an index finger over the top of the densitometer to temporarily obscure vision through the optical sighting device, then level the device using its internal bubbles, then uncover the top of the densitometer and note whether or not the device pointer is encountering tree canopy, and the tree species.

The observer will repeat these procedures for all points, and also for the end point at the chain pin marking the bankfull bank. If there are two bankfull channels, the observer will repeat all procedures for the second bankfull channel.

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SOP 6. Delineation of Streams and Watersheds at Pinnacles National Monument

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
-	September 2009	Denn, M.	-	-	1.0

Introduction

This section documents the procedure project network staff employed to delineate all park watersheds of one square kilometer or greater, and also determine which stream reaches in the park have catchment basins of greater than three square kilometers. The watersheds are not relevant to the sampling frame for this project; they are delineated merely to organize the stream system for data collection and reporting purposes. However, these watershed units correlate with those that park managers usually reference for work in the park. The three-kilometer catchment size as a cut-off for stream reaches to be included in the sample is based on conversations between network and park staff. Stream reaches with three-kilometer watersheds or greater are those that are most likely to support a phreatophytic riparian community and in-channel wetlands. Stream reaches above the data-collection stream network generally do not have adequate year-round surface or near-surface water to support woody riparian habitat or in-channel wetlands.

Project staff then imported a 10 meter digital elevation model (DEM) of PINN and a USGS vector shapefile (reachfile 3) of the PINN stream network into ArcGIS 9.2 (ESRI 2008).

Project staff then utilized program Arc Hydro Tools (CRWR 2009) to delineate watersheds and drainages using the DEM and the USGS stream shapefile. The procedure for this is provided in the Arc Hydro Tools Tutorial (ESRI 2005). Project staff input the following parameters during the process:

DEM Reconditioning Procedure: This function modifies a DEM by imposing linear features (*e.g.,* a stream network) onto it.	
Stream Buffer: the number of cells around the linear feature for which landscape smoothing occurred on the DEM	5 cells
Smooth drop/rise (DEM Z-unit): the amount, in vertical units, that the linear feature was dropped or raised - used to interpolate the DEM into the buffered area	10 DEM units (10 m)
Sharp drop/rise (DEM Z-unit): the additional amount, in vertical units, that the linear feature was dropped or raised - resulting in additional burning/fencing on top of the smooth line buffer interpolation to preserve the linear features originally used burning/fencing	1,000 DEM units (1,000 m)
Fill Sinks Procedure: If a cell is surrounded by higher elevation cells the water is trapped in that cell and cannot flow. This function filled the sinks in the PINN DEM.	
Parameters	no deranged polygon specified Fill All (no fill threshold specified)
Watershed Delineation Process: This function computes a stream grid for the purpose of delineating park watersheds. The function assigned a value of "stream" to each cell which has a drainage catchment greater than the threshold. A smaller threshold would result in a denser stream	

network and subsequently, a greater number of delineated watersheds.	
Number of DEM cells: the number of raster cells in the DEM which must drain to a cell in order for that cell to be classified as "stream"	10,000 cells
Area (square kilometers): variable specified above, converted to aerial extent	1 square kilometer
Stream Delineation Process: This function is the same function as above, run again for the purpose of delineating the stream network. The function assigned a value of "stream" to each cell which has a drainage catchment greater than the threshold. The function resulted in a linear stream system, with stream headwaters beginning at a specified position in each watershed (dependent on catchment size).	
Number of DEM cells: the number of raster cells in the DEM which must drain to a cell in order for that cell to be classified as "stream"	30,000 cells
Area (square kilometers): variable specified above, converted to aerial extent	3 square kilometers

The output of this process, using Arc Hydro Tools, was two ESRI ArcGIS shapefiles: one is a polygon shapefile delineating the 19 basins in the park greater than one square kilometer (see Chapter 1 of the Protocol Narrative), the other output from the procedure is a line shapefile of all major streams in the park, up to the point in the watershed where they have a catchment size of three square kilometers or less. Minor streams (those that have no reaches with an adequate catchment size, even in the lowest portions of the stream) are not included in the output.

Project staff then hand-digitized a point shapefile to mark each end of the data-collection stream network - identifying either where the stream crosses the park boundary, or identifying the point at which the stream watershed is less than three kilometers. Coordinates generated from this shapefile will be loaded into the field GPS unit each summer for determining the end points of the data-collection stream network. Project staff also marked confluences of major and minor streams. These points will also be loaded into the field GPS each summer to aid with navigation in the field, although determination of the location of data-collection reaches at confluences is conducted in the field according to stream morphology (see Chapter 2 of the Protocol Narrative).

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SOP 7. Riparian Classification System, Wetland Classification System, Lists of Wetland Plants, and Key to Vegetation Communities of Pinnacles National Monument

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
-	September 2009	Denn, M.	-	-	1.0

Figures

Riparian Classification System

This protocol employs the US Fish and Wildlife Service Riparian Classification System (Figure SOP 7.1). For more detailed descriptions and photos of riparian habitat types, see USFWS 1999. The riparian system types found at Pinnacles NM included in this monitoring effort are Lotic Scrub-shrub and Emergent. Lentic riparian systems are limited at Pinnacles NM to habitats surrounding the Bear Gulch Reservoir and are not included in this study. Pinnacles NM does not support any Forested Lentic riparian habitat.

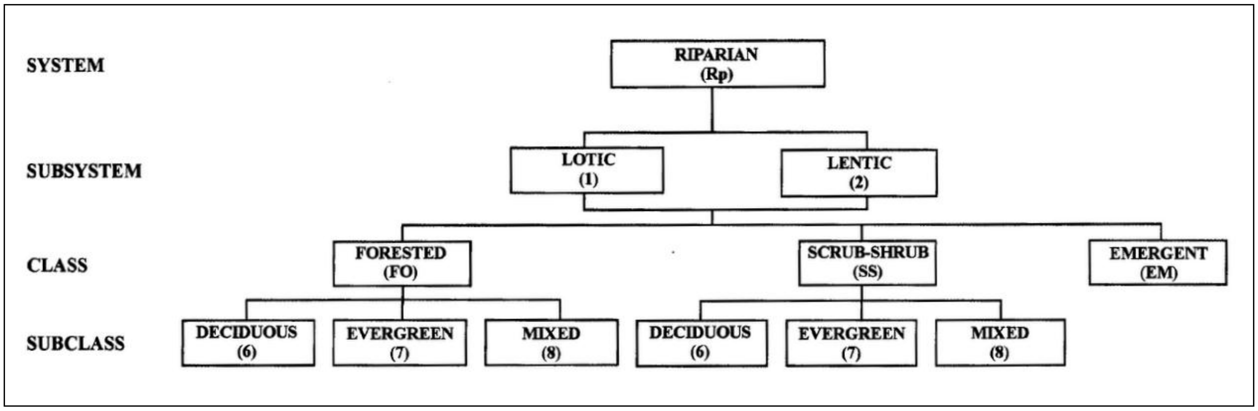

Figure SOP 7.1. USFWS Riparian Classification System.

Wetland Classification System

This protocol employs the Cowardin Wetland Classification System (Figure SOP 7.2). For more detailed descriptions and photos of wetland types, see Cowardin *et al.* 1979. The most commonly observed wetland types at Pinnacles NM within the stream channels are Palustrine Rock Bottom, Palustrine Unconsolidated Bottom, Palustrine Aquatic Bed, and Palustrine Emergent wetlands. Cowardin reserves the "Riverine" system designation for much larger fluvial systems than found at Pinnacles NM.

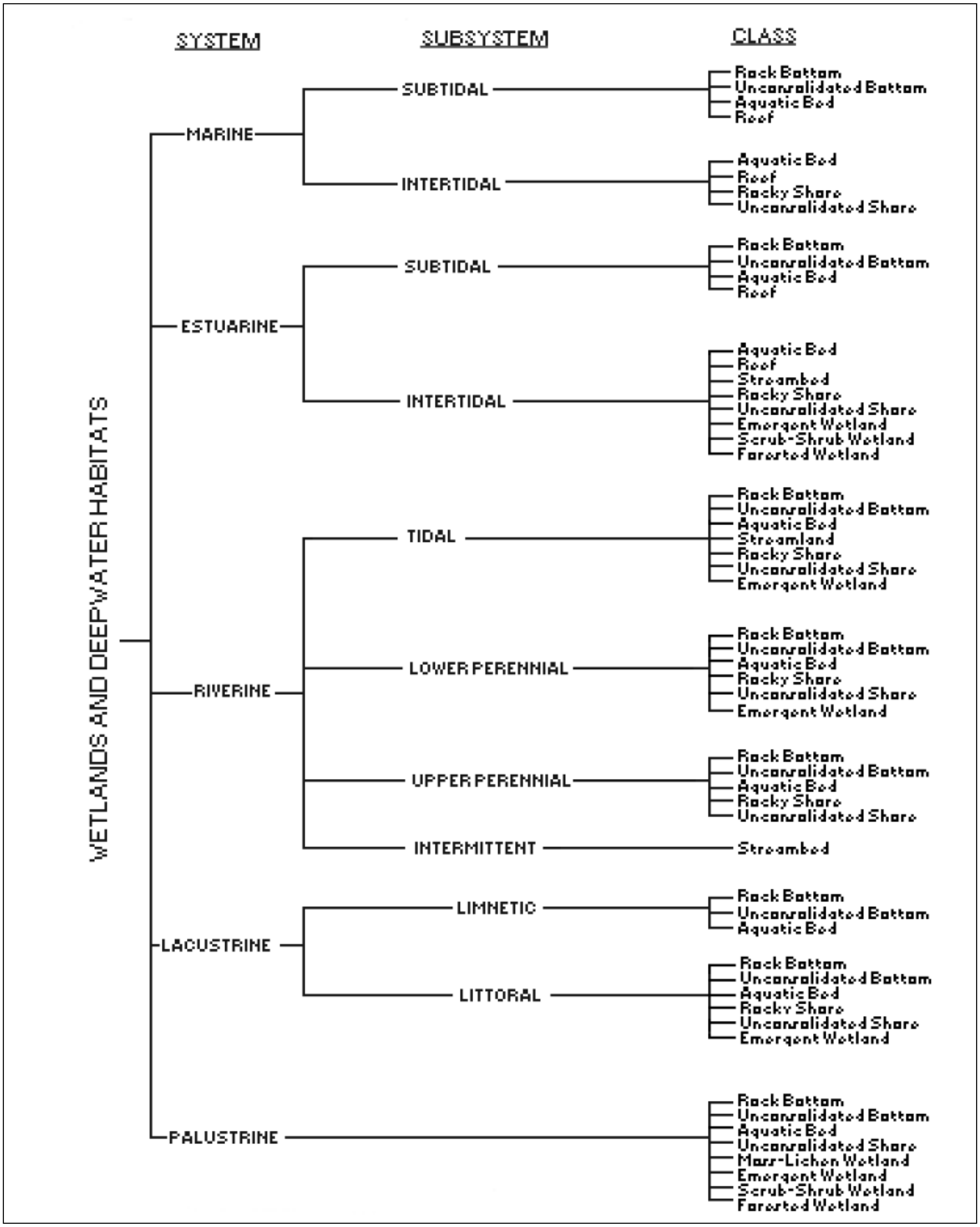

Figure SOP 7.2. Cowardin Wetland Classification System.

SOP 7.3 Lists of Wetland Plants for Identification of Wetland Habitat

The Botany Technician will carry a list of wetland plants with their wetland indicator status during fieldwork. There are two national lists of wetland plants with wetland indicator status: Reed 1988 and Reed 1996. This protocol uses the '96 list, as this plant list is more inclusive and better represents the likelihood of each plant's propensity to grow in mesic habitat (Tiner 2006) than the '88 list. However, the US Army Corps of Engineers has not yet adopted this list for wetland delineation, due to concerns about its application in the Southeast region of the United States. Personnel for *this* protocol should be sure to only use the '96 list for consistency between years. For the purposes of this protocol, observers will use the California (EPA Region 10) wetland plant indicator status where one exists; otherwise observers will use the National indicator status. Observers will also use the "intermediate" indicator status values (*i.e.,* FAC -), although the US Army Corps of Engineers Arid West Supplement (USACOE 2008) now prescribes dropping the intermediate status values.

The list is available online at http://library.fws.gov/Pubs9/wetlands_plantlist96.pdf.

SOP 7.4 Key to Plant Communities of Pinnacles National Monument

The Key to Plant Communities of Pinnacles NM (Kittle 2009) is in draft, and may be revised and finalized in the future. Revisions will most likely consist of addition of new classes for previously un-described communities and/or splitting of existing classes. When and if the key and classification system are updated this protocol should adopt the new system, as collection of plant community data are primarily for the purpose of mapping the current status of the stream channels in the monument to provide current natural resource information to managers, not primarily for the purpose of change detection. However, data collected under this riparian habitat monitoring program can be used for landscape-scale change detection if the managers of this monitoring program track changes to the plant community classification and create a cross-index (if possible) between older classification categories and revised categories.

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SOP 8. Weed and Wildlife Watch List Species and Reporting Procedures

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
-	September 2009	Denn, M., Johnson, P.G., Johnson, B.	-	-	1.0

Weed Watch Species

The following non-native and noxious plant species are those that the San Francisco Bay Area Network Vegetation Working Group identified as critical for management at Pinnacles National Monument. Each of these species has a strong potential to degrade riparian habitat and is now found in limited abundance within the park. This list will be reviewed and updated in consultation with the network Vegetation Working Group (including the Pinnacles NM vegetation manager) at the beginning of each data collection season. The network Vegetation Working Group - at a minimum - includes the Vegetation Management Specialists at Pinnacles NM, Golden Gate National Recreation Area, and Point Reyes National Seashore, as well as the network vegetation ecologist.

The project Botany Technician will actively look for these species in each reach observed during data collection, and estimate the absolute cover within the reach of any of these species observed, according to the vegetation cover estimation protocol found in SOP 5.

These data will be reported to park and network staff in weekly updates and at the end of each field season as part of the protocol End of Year Report.

List of Non-native and Noxious Plant Species

Acroptilon repens	Russian knapweed
Ailanthus altissima	Tree-of-heaven
Arundo donax	Giant reed
Centaurea melitensis	Napa thistle, tocalote
Centaurea solstitialis	Star thistle
Chenopodium ambrosioides	Mexican tea
Conium maculatum	Poison hemlock
Dittrichia graveolens	Stinkweed
Iris pseudacorus	Yellow flag
Marrubium vulgare	Horehound
Melilotus alba	White sweetclover
Mentha spicata	Peppermint
Nicotiana glauca	Tree tobacco
Rubus discolor	Himalayan blackberry
Tamarix ramosissima	Tamarisk

Wildlife Watch Species

The following animal species are those that the wildlife management staff at Pinnacles National Monument listed as being critical for management at the park, either because these species are non-native and noxious (*i.e.*, mosquito fish, green sunfish and the field-indistinguishable bluegill, bullfrog, wild pig, and crayfish), or of conservation concern (*i.e.*, white-tailed kite, red-legged frog, and owl and other bird-of-prey species). Birds-of-prey will not need to be identified to species (except for the white-tailed kite), however observers should note the species if they have a confident identification, or note other characteristics that may help wildlife staff with species identification. This list will be reviewed and updated in consultation with the park wildlife management staff at the beginning of each data collection season. Both project technicians will actively look for these species in each reach observed during data collection, and report the number of individuals any of these species observed.

These data will be reported to park and network staff in weekly updates and at the end of each field season as part of the protocol End of Year Report.

List of Wildlife Watch Species (Non-native, Noxious, or Of Concern)

Clemmys marmorata	Western pond turtle
Gambusia affinis	Mosquito fish
Elanus leucurus	White-tailed kite
Lepomis spp.	Green sunfish *or* bluegill
Rana catesbeiana	Bullfrog
Rana draytonii	CA red-legged frog
Sus scrofa	Wild pig
Various	Crayfish
Various	Owl
Other bird of prey	

NPS 114/110565, September 2011

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